1994

The Electronic Bulletin Board as a Means of Professional Communication Among Physics Teachers

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by

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A dissertation report submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Computing Technology specializing in Computer Education

Nova University

June 1994

Acknowledgements

This project was guided and assisted by many people. What follows is an attempt to recognize those people who helped the project reach its final form. The listing that follows is chronological in nature.

The first project discussions were with Dr. Mary Ellen Sapp who encouraged a project based on high school physics teachers and telecommunications. Dr. Al P. Mizell guided the development of the original idea into a more concrete form. Dr. Marlyn Kemper Littman was helpful in clarifying the original ideas so that a project would emerge that was of value to the physics teaching community. Dr. George Fornshell assisted with the original idea and has served as an advisor on the final project. Dr. Fornshell helped narrow the topic so that the project was practical and meaningful. Dr. Thomas MacFarland guided the project through the concept stage helping to clarify the expectations and goals of the project. Considerable assistance dealing data analysis was received from Dr. Steven Terrell. Finally, the entire proposal and report phases of the project were guided and directed by Dr. John Kingsbury, without whose patience and continued assistance this project would never have reached completion.

Abstract

Teachers of secondary school physics are often physically isolated from their peers; that is, they do not have as much contact with their physics colleagues as they desire. One reason for this physical isolation is the relatively small population of students enrolled in high school physics courses resulting in small numbers of physics teachers per school. Another is that many physics teachers are teaching physics only part time.

One method of communication among teachers has the potential to improve professional communication among physics teachers. This is the computer operated electronic bulletin board system (BBS). Bulletin board systems and variants have been studied for more than ten years. At least one is being operated primarily for physics teachers.

This study was designed to determine the effectiveness of a BBS as a means of professional communication among physics teachers. Effectiveness was determined by surveying physics teachers in three categories: (1) those who are using a BBS to communicate, (2) those who are members of a physics teachers association, and (3) those who have neither of these formal means of communication available to them. School data (population, graduation requirements, number of physics classes and teachers, etc.) and personal data (years teaching physics, teaching assignment, certification, professional affiliations, etc.) were gathered from all three groups. The experimental group using the BBS was asked to supply additional information about the use of the BBS itself. Data were gathered using a questionnaire.

The BBS users were compared to the other groups to determine whether they are representative of the physics teacher population and whether their desires for additional professional communication are similar to that of the physics teacher population. Survey responses by BBS users about the BBS itself were then used to determine the effectiveness of the BBS as a means of professional communication.

Statistically significant differences among the three groups were found and are discussed. Comparisons were also made between the three groups and the population of physics teachers in the United States as presented in an American Institute of Physics report. Of greatest importance, differences exist among the three groups when tested for professional contact with physics colleagues. No differences were found among

the three groups when desire for additional professional contact was tested.

Survey results for the group of BBS users showed that they were experienced computer users who expressed no unusual difficulties with the mechanics of connecting to the BBS. Many did express difficulties with the BBS as a means of professional communication. Two important problems discussed are difficulty in using all system options and the small number of active participants using the BBS. BBS users expressed confidence in the system's potential as a professional communications system, but were less enthusiastic about it had served their needs. Overall, the problems experienced by BBS users were not offset sufficiently by the benefits to make the system as effective a means of professional communication as it could be. The potential of the electronic bulletin board system as a means of communication among physics teachers did not live up to its perceived potential for the group of users studied.

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I. Introduction

Problem Statement

The problems and concerns of one teacher are sometimes similar to those of other teachers. Riel and Levin (1992) contend that "teachers spend most of their time in classrooms isolated from one another" and that, unlike other professionals, they "have very little access to telephones or other means of interaction with others outside the classroom" (p. 68). As a result, "teachers need support from other professionals who work in similar situations and whose collective experience can provide insight and helpful suggestions" (Gal, 1993, p. 102). Effective communication is essential for professional support among teachers. Gal, Lockett, and Parrott (1993) believe that a supportive community is key to effective teaching and that "ongoing dialogue with fellow professionals helps teachers reflect on their experience, understand it, and change it" (p. 64).

According to Drayton (1993), although communication among teachers in general is difficult, communication among science teachers is often more difficult because they "tend to be isolated from teacher colleagues on the one hand, and from colleagues in their science on the other" (p. 149). In particular, teachers of physics have difficulty communicating with one another because "isolation is a fact of life for many teachers of physical science" (Ruopp & Pfister, 1993, p. 2). Ruopp (1993) argues that "documented isolation of physics teachers from colleagues who do the same work must be widespread" (p. 294).

Physics teachers have several means of communication available to them. National and local organizations can provide teachers with avenues of exchange of ideas "but only for those who have learned to seize them" according to Ruopp (1993, p. 295), who concludes that "this is a smallish subset of those who teach physics." Drayton echoes these conclusions, writing that professional organizations "supply some of what is missing, by occasional large meetings and publications" (p. 155). These efforts are not adequate "because of their infrequency and removal from teachers' daily practice" (Drayton, p. 155). Ruopp and Pfister (1993) maintain that contact with other science teachers and attendance at professional meetings are valuable means of communication but that they "cannot substitute for daily intercourse with those practicing the same craft" (p. 2). Ruopp summarizes these assertions by claiming that there is no national community of practice for physics teachers and that "such a community is rare at the state and local level" (p. 294). Physics teachers have been chosen as the population for this study because many of them are isolated from their peers and because the current means of communication open to them are inadequate.

Newer, non-traditional communications systems may be more effective as a means of professional communication for physics teachers than existing methods. One such method of communication is the computer-based electronic bulletin board system (BBS). According to Ruopp (1993), communication using computers, is "the communications medium of choice for supporting the high school (and elementary) science-teaching community" (p. 299). Gal (1993) characterizes computer communication as "particularly helpful in facilitating shoptalk discussions" and claims that "the medium lends itself to short, concise, and informative discourse" (p. 115).

According to Wood and Blankenhorn (1990), BBSs have existed for more than a decade and are in widespread use in the United States. A BBS allows users to exchange electronic mail messages, text files, and computer programs. Riel and Levin (1992) add that "the most common form of interaction on electronic networks is the exchange of electronic messages" (p. 61). By enabling exchanges of messages and files, the BBS may have the potential to improve professional communication among physics teachers. Therefore, the BBS has been chosen as the communications system for this study.

Background

In 1988, the American Institute of Physics [AIP] published the results of a major survey of American physics teachers (Neuschatz & Covalt, 1988). According to this report, professional communication with other science department members is generally not a problem for physics teachers; more than half of those surveyed report frequent contact with science department colleagues and only 15 percent desire additional contact. However, nearly half of those surveyed also expressed a desire for additional professional contact with other physics specialists (Neuschatz & Covalt, 1988). Frequent contact with departmental colleagues, then, does not satisfy the need for high school physics teachers to communicate with other physics specialists.

Describing the working conditions of physical science teachers, Ruopp and Pfister (1993) state that "they are often the sole practitioners in their schools" (p. 2). Physics teachers are often limited in their ability to engage in professional communication because "many schools have only one teacher for each science specialty" (Drayton, 1993, p. 154). According to Ruopp (1993), "it is safe to say that few districts have more than one or two--certainly not five--physics teachers--there are 15,267 public school districts and only some 8,000 high school teachers of physics" (p.294). The problem may be most acute in small schools where each course is taught by only one or two teachers. But, according to an American Association of Physics Teachers [AAPT] report (1988b), even in large schools many physics teachers find professional communication with other physics specialists difficult due to the small number of physics sections offered. This is the case for most physics teachers according to Neuschatz and Covalt (1988) who state that "90% of all public high schools with physics have only one physics teacher" (p. 6). A majority of physics teachers are unable to communicate with other physics teachers during the school day and must look outside for professional contact with other physics specialists.

A related difficulty is that many physics teachers also teach other subjects. According to Neuschatz and Covalt (1988), the ratio of physics classes to physics teachers is 1.97 and "only 13% of the respondents had teaching assignments in physics alone" (p. 17). Many physics teachers do not teach physics full time and many high schools offering physics employ less than the equivalent of one full-time physics teacher.

Although many physics teachers desire additional communication with other physics specialists, the way they perceive this situation is also important. Teacher perceptions were also considered by Neuschatz and Covalt (1988) who found that "only 10% of respondents reported frequent contact with physics teachers at other high schools or at institutions of higher learning" (p. 24). They also found that almost half the teachers indicated "a desire for greater professional contacts" (p. 24). Interaction with other teachers was also investigated by Neuschatz and Covalt and was found to be greatest with fellow teachers in the respondents' own schools, but far less with physics teachers in other high schools and in higher education. In analyzing comments added by respondents to the AIP survey, Neuschatz and Covalt (1988) found several common themes. One of these was a feeling of physical isolation, especially from other physics teachers and physics professionals. Teachers "felt a lack of emotional support and camaraderie, as well as missing the chance to exchange ideas and techniques for use in the classroom" (p. 39).

Many physics teacher organizations hold regular meetings for teachers working in small geographic areas. A directory of support services available to precollege physics teachers (AAPT, 1988a) indicated that 113 of the 132 organizations listed hold regular meetings and/or workshops. These increase teacher-to-teacher contact for those who attend. Professional meetings can establish communications channels among physics teachers, but attendance at these meetings is not a regular practice of many physics teachers according to Neuschatz and Covalt (1988). In addition, those attending are likely to teach physics full time and be members of professional organizations according to the same report.

Physics teachers use many methods to communicate with their colleagues. These include professional meetings, mass media, scientific journals, school-year workshops, and summer institutes. However, these methods are not meeting the needs of nearly half the physics teacher population.

Significance

Gal, Lockett, and Parrott (1993) claim that "feelings of isolation are probably more common among teachers in geographically remote places or those in small schools where they are 'the whole science department,' but teachers in large high schools can experience these feelings too" (p. 71). Although high school physics teachers rely on many forms of professional communication (journals, mass media, meetings, workshops, and institutes), nearly half desire greater professional contact according to Neuschatz and Covalt (1988). Existing methods of professional communication are not meeting the needs of nearly half the physics teachers in the United States. The lack of effective communication is perceived as a problem by physics teachers and many desire additional professional contact.

Lack of communication is also a problem because "many teachers with little or no preparation in physics are called on to teach physics" (AAPT, 1988b, p. 9). Neuschatz and Covalt (1988) found that even though survey respondents were experienced physics teachers with strong academic backgrounds, "few could accurately describe their careers as being primarily devoted to the field" (p. 17), and "some 70 percent report having begun their teaching career in a specialty other than physics" (p. 17). Many described themselves as occasional teachers of physics who felt much less confident in their preparation even in the basics of physics teaching. A similar problem was reported in an earlier report by the National Science Foundation (1982). According to this report, 93 percent of the states surveyed reported a shortage of physics teachers and 50 percent of the newly employed secondary science and mathematics were uncertified to teach those subjects. During the decade before the report became available, the number of student teachers in science decreased by 67 percent and only half of this group actually entered the teaching profession. Finally, one-fourth of those teaching science expected to leave the profession in the near future.

Neuschatz and Covalt (1988) concluded that the scarcity of schools where teachers devote themselves to physics "probably works to discourage some prospective teachers from choosing the field as their area of specialization" (p. 52). In combination with other factors such as low salaries and lack of prestige, this "limits the number of physics specialists entering high school teaching" (p. 52). A result is an increase in the number of schools that must "draft" physics teachers from other specialties. The draftee is characterized in the AAPT (1988b) report as a teacher who "desperately needs the support and encouragement of colleagues" (p. 9). This support is not available within the draftee's school building if he or she is the only physics teacher. This is likely, since "90% of all public high schools have only one physics teacher" (Neuschatz & Covalt, 1988, p. 6).

The current population of physics teachers includes many who are under-qualified or unqualified in the subject according to the AIP report (Neuschatz & Covalt, 1988) and the earlier National Science Foundation (1982) report. Lack of communication with others in the field is cited by many as a problem. In combination, these conditions are serious in terms of the future of physics education.

Rationale and Purpose

This study is designed to determine whether a BBS is effective in meeting the professional communications needs of high school physics teachers. Communications systems such as meetings and publications that are already in widespread use by physics teachers were not considered because they are not meeting the communications desires of nearly half the physics teacher population. Although the value of meetings and publications may be great, the problems of lack of professional communication are still widespread.

The design and implementation of a BBS for physics is not necessary. Electronic bulletin board system software that operates on a microcomputer has been available for at least a decade according to Wood and Blankenhorn (1990). BBSs have not yet had an effect on most physics teachers, however. The support services directory (AAPT, 1988a) cited above listed only two BBSs operated primarily for physics teachers.

An operating, physics teacher BBS was used for this study. First its effectiveness (or lack of effectiveness) as a means of professional communication among physics teachers was determined. The characteristics responsible for its effectiveness or lack of effectiveness were then determined. Results are described in Chapter IV.

Variables, Hypotheses, and Objectives

The purpose of this study is to determine whether an electronic bulletin board system is an effective means of professional communication among physics teachers. To make this determination several variables were measured in two broad categories. First, user opinions were elicited so that the effectiveness of the BBS could be determined. Opinions are subjective and are presented in narrative format. Some opinion information, especially that relating to satisfaction with the system and problems encountered using it, can also be presented using descriptive statistics. Second, demographic information was obtained so that the experimental group can be compared to two other groups of physics teachers. Demographic information includes teaching assignments, background, training, professional association memberships, and characteristics of the participant's school.

Research Questions

This study was designed to determine the effectiveness of an electronic bulletin board system as a means of professional communication among physics teachers. For a determination to be made, an operating bulletin board system used primarily by physics teachers was studied. The effectiveness of the system was determined by answering the following research questions: (a) Is the system under investigation effective in allowing and encouraging physics teachers to communicate with one another? (b) If so, what characteristics of the system make it effective? If not, what characteristics inhibit its effectiveness? (c) What are the professional characteristics of the system users and how do these correlate with system effectiveness?

Assumptions

According to the AIP national survey of physics teachers (Neuschatz & Covalt, 1988), "only 10% of respondents reported frequent contact with physics teachers at other high schools or at institutes of higher learning" (p. 24). They also report that "almost half the teachers indicated a desire for greater professional contact" (p. 24). It is assumed that those who use electronic telecommunications systems are communicating effectively if they report that use of such a system is meeting their professional communications needs.

Another assumption is that the effectiveness of a communications system used by physics teachers can be used to predict the effectiveness of similar systems implemented for other groups of physics teachers. However, since the type of system under study is new to the physics teaching community, users may not be representative of all physics teachers. Teachers who use new communication systems might be more computer literate than other physics teachers. Thus, if a bulletin board system is found effective for current users, there is no assurance that other groups of physics teachers would find it effective. The effectiveness of a BBS as a means of professional communication may depend on the personal or professional characteristics of its users.

Finally, it is assumed that a variety of physics teachers will elect to use the BBS. If under-qualified physics teachers and "draftees" choose not to use the system, it is not serving the needs of all physics teachers. It is possible that physics teachers who use the BBS are also communicating in other ways. For them, the system may serve only as a supplementary means of communication.

Limitations

The experimental group consists of physics teachers from a small geographic area who are voluntarily using an existing BBS. Therefore, the size of the experimental group (n = 25) is small compared to the control groups and the population of physics teachers. Members must have access to the necessary computer hardware and software and be sufficiently computer literate to use the system as a means of professional communication. Conclusions, then, are limited to other small groups of physics teachers who are at least minimally computer literate.

The BBS selected as the target system was operational before this study began. Therefore, it was not possible to determine the extent of professional communication that existed for participants before they started using the system. A comparison between the experimental and control groups was made to determine whether the experimental group is representative of other groups of physics teachers. Conclusions are limited by any significant differences.

Definition of Terms

Computer bulletin board system (BBS)

According to Freedman (1989), computer bulletin board systems are "computer systems that function as centralized information sources and message switching systems for a particular interest group" (p. 80). Ruopp and Pfister (1993) list "text, graphics, computer code, even sound" as being exchanged. (p. 19). Riel and Levin (1992) state that the most common form of interaction is "the exchange of electronic messages" (p. 61).

Physics teacher

For the purposes of this study, a physics teacher is anyone who teaches at least one section of high school physics. Neuschatz and Covalt (1988) list possible physics courses as "regular first year, honors, advanced placement, second year, physics for non-science majors, and other types of physics" (p. 8).

Summary

High school physics teachers, more than teachers of many other subjects lack an effective means of professional communication. One possible way to improve professional communication among them is the use of a physics teacher oriented electronic bulletin board system. This study is designed to determine whether such a system allows its users to communicate effectively.

The results of this study will allow organizations of physics teachers to determine whether implementing a similar system would benefit their memberships. This study will also provide information about characteristics that determine system effectiveness and about characteristics of the user population most likely to benefit from its use.

II. Review of the Literature

Introduction

Literature references to computer-based communications projects for teachers can be categorized according to the teacher groups for which they were designed and by the equipment on which they operated. The earliest references are to government-funded projects operated on mainframe computer hardware and open to all teachers. The first of these is the University of Alaska Computer Network. The earliest report of this project was published by the Alaska Department of Education (1979). A more detailed account was presented by Seguin (1988). Another statewide system was operated in Maryland and was described by Heidelbach (1984). Although the report of its operation is older than desirable, the system had a unique structure consisting of a statewide connection of smaller networks. No other system described here used this method of computer connection.

A mainframe-based project operated in New Jersey (Bloom & Rabinowitz, 1985) included a detailed evaluation procedure to determine participant satisfaction with the system. It also operated successfully with a small (25) number of participants all of whom were science teachers or science supervisors. Because of these project characteristics, the work of Bloom and Rabinowitz (1985) is included, although the report cannot be considered current.

Two projects designed to improve professional communications among teachers of agriculture are briefly included. Reynolds (1986) described a pilot program in Wyoming and Camp (1987) report on a state-wide communications system in Virginia. Also briefly included is a 1988 report by Schrum that describes the telecommunications component of a larger project. This project component was initiated to allow participating teachers to communicate professionally with other teachers having similar interests. Physical isolation of project participants was considered important enough in this project to warrant the use of a computer-based telecommunications system. All of these systems relied on mainframe computers for communications among teachers having common interests.

The project described by Katz, McSwiney, and Stroud (1987) is the only one that used microcomputers to operate a communications system. The project was designed to improve professional communication among participants, who were science teachers or supervisors.

Technical Education Research Center [TERC] of Cambridge, Massachusetts has developed several telecommunications projects. These progressed from a project for the National Geographic Society to the LabNet project that ended in 1992. These were, for the most part, curriculum development projects, but each contained a communications component.

Description of Communications Projects

Referring to secondary school teachers in general, Heidelbach (1984), describing a computer-based telecommunications system in Maryland, noted that "teachers are in many ways isolated from a great deal of the information that they need in order to make judgments as they implement a new technology in their classrooms" (p. 4). As a solution to this problem, inservice programs are offered in many school districts and colleges. Schrum (1988), in the report of a California training institute that included a computer-based telecommunications component agreed, and added that "teaching should not be an isolated profession; telecommunications is allowing teachers to be more productive, to stay in touch with current trends and to improve their students' education in innovative ways"

(p. 89). New methods of communication may allow problems of professional communication to be economically addressed. These methods were first tested in places where physical isolation is a result of geography and population density. As solutions to the problem of professional communication become available and affordable they may be used in more populated areas where physical isolation is a result of segmentation rather than geography.

In Alaska "communications are a major problem" for all teachers (Seguin, 1988, p. 81). Alaska was one of the first states to establish a computer-based communications system for its schools (Seguin, 1988). The University of Alaska Computer Network (UACN), is a state-wide system linking ten colleges and each of the state's 56 school districts. The UACN system is run on three interconnected Digital Equipment VAX mainframe computers. The system has over 6,000 registered users, including college students, public school districts, university chancellors, and teachers. A system this size is needed to span the great distances in Alaska. According to an early report by the Alaska Department of Education (1979), the project began in 1975 under a grant from the State legislature. As a preliminary project, many methods of communication were tested.

After a year of operation under pilot conditions, the most promising technologies were chosen for full scale implementation. When the system was only one third operational, it was already supporting over 100 messages per day, testifying to the positive attitude of teachers toward electronic mail. Seguin (1988) noted that this preference continued and that electronic mail "accounts for the heaviest use of the statewide network" (p. 81). When Alaskan educators are offered a variety of telecommunications options, they prefer electronic mail. This suggests that electronic mail should be included in a telecommunications system serving teachers. It also suggests that teachers find electronic mail a valuable means of communication.

As of 1992, UACN was still operational. The system had expanded and, at that time, provided access to the Alaska Teleconferencing Network and to commercial communications services. It was also connected to the Internet and to BITNET according to Clement (1992). The scope and size of the UACN is beyond that needed by local physics teacher organizations. Parts of the system, especially the electronic mail component, could be duplicated using a smaller computer serving smaller populations in more isolated geographic areas.

Physical isolation is also a problem for teachers of vocational agriculture in areas where professional communication is difficult. Information on market and weather conditions, for example, must be timely to be of value in the classroom. A pilot project in Wyoming (Reynolds, 1986) was used to determine whether computerized telecommunications could help agricultural teachers obtain current information appropriate for their courses and students. The project included fifteen sites connected electronically to a commercial agricultural information service. Funding from the Wyoming State Department of Education paid for equipment, training and subscriptions to a commercial information service.

Although much of the value of this project arose from the timeliness of the available data, two parts of the project are important to this study. The information system provided teacher access to more than 500 curriculum lessons on a wide range of topics related to agricultural education. Teachers found access to these lessons valuable and used them often according to the author. In a system where teachers could more freely exchange information and files, it would be possible for participants to be the suppliers of lessons as well. The Wyoming project demonstrated that when quality lessons are available teachers make use of them.

Another component of the Wyoming project that participants found useful was electronic mail. Teachers made use of this relatively new method of communication to maintain contact with their peers, increasing their level of professional communication. The vocational agriculture teachers involved with the project were beginning to benefit from electronic mail when the report was written.

A similar project for agriculture teachers in Virginia was described in a report by Camp (1987). The project, funded by the State of Virginia, was judged "not economically practicable" (Camp, 1987, p. 3) because the number of teachers served was "not adequate to justify the expenditure of state funds on a full-scale network" (p. 3). Camp stated, however, that "the technology is too important to our educational system's and our students' futures, for us to simply give it up" (p. 3). Camp further argued that the project represented a good investment because it represented a new direction for teacher communication in the future, not because it met its primary objectives of servicing the immediate needs of Virginia's teachers of Agriculture.

The Virginia system described by Camp (1987) was run without the use of commercial information services. The state provided funding for the main computer, training of participants, and equipment to access the system. The system collected over 300 "sets of information" including lesson plans, instructional materials, tests, and learning activity packages. Many were provided by participants. System use showed that teachers are willing and able to share classroom teaching materials when given an efficient method to do so. Teachers found value in the system and were willing to contribute to its library of available information.

A less structured computer network was established in Maryland (Heidelbach, 1984). The system was based on the mainframe Maryland Education Microcomputer Network (MEMN) and enhanced by smaller networks operating on microcomputer hardware. The smaller networks allowed participants access to the entire system through a local contact. The system was open to "all Maryland citizens involved with the mission of our schools" (Heidelbach, 1984, p. 1). Participants included "teachers, children, parents, social workers, counselors, medical workers, professors, supervisors, administrators, information specialists, librarians, computer specialists, interested citizens and persons from other cultures" (p. 1).

The MEMN system was an open exchange system where system administrators coordinated but did not influence its topical content. Although the system offered users no formal training, teachers were the most active system users and activity was greater in the homes of teachers than in schools. The system's success is an indication that teachers will overcome technical obstacles in order to access an effective communication system.

According to Clement (1992) this network, now based on Learning Link is still operational. The name has been changed to METNET and it is still open to all educators in the state. Access is now toll-free.

A teacher telecommunications network was part of the Elementary Summer Technology Training Institute, sponsored by the State of California. According to Schrum (1988), the network was used to introduce participants to computer technology, allow them to communicate information and ideas, and provide feedback. The telecommunications system ran on a commercial network.

Due to inadequate teacher education, less than half of the first-year participants made worthwhile use of the telecommunications system according to Schrum (1988). A small number however, "became totally committed and made this technology part of their teaching and professional resources" (p. 86). Due to more effective training during the second year of the program "a large majority of the 200 participants had logged on, and the number of them still active in the system is impressive" (p. 89).

Bloom and Rabinowitz (1985) described early project designed to improve inservice training of teachers in New Jersey. The Electronic Information Exchange System (EIES) was used for the communications portion of the project. Part of the project was an electronic message system similar in concept to an electronic bulletin board. The 25 participants who were all physics and chemistry teachers and science supervisors were geographically separated before and after summer training sessions. Evaluation was made using questionnaires.

Bloom and Rabinowitz (1985) reported that participants who rated EIES most favorably were active system users and that participants with less teaching experience rated the system more favorably than experienced teachers. The communications system was used to discuss instructional and classroom issues, share information, solve instructional problems, and coordinate joint activities. Some Participants expressed difficulties using EIES due to insufficient training and the complexity of the mainframe communications system. Those who continued using EIES in spite of difficulties, reported that it positively influenced their classroom instruction, allowed them to interact with college and high school faculty, and encouraged professional growth. These results indicate that some science teachers are willing to use electronic communications to increase professional interaction with colleagues and that there are benefits even when the number of participants is small.

Katz, McSwiney, and Stroud (1987) described a computer conferencing project undertaken by the Educational Technology Center (ETC) in Cambridge, Massachusetts. The ETC studied the effect of a computer conference system on the exchange of ideas and information among science teachers. The system was designed as means of collegial exchange among members of small groups and was operated on a microcomputer. Participants were volunteers who used their own equipment and paid telephone costs. Membership was restricted to between 40 and 50 participants, most of whom were experienced teachers with a mean of thirteen years experience. The system was used primarily for making and replying to inquiries, and exchanging information related to science teaching. Message areas for each science teaching discipline were available to all participants, but members most frequently accessed their own subject areas. Communication within subject areas was more frequent than communication across subject areas.

Approximately one fourth of the participants were very active while the others were occasional users or stopped accessing the system. Overall, Katz, McSwiney, and Stroud (1987) reported that "two thirds were entirely positive in their evaluation of it" (p. 32) and that many teachers who used the system only occasionally found it "extremely valuable and useful" (p. 27). They also reported that teachers who felt physically isolated from their peers used the system more often than others and that a lack of colleagues was positively correlated with system use and that "teachers with fewer informal contacts with colleagues outside of school logged in and read more, and did relatively more public writing" (p. 29). Members were not generally familiar with each other and the ETC staff concluded that this had a negative effect on participation by some members.

In the final evaluation of the system, nearly half the participants expressed the opinion that the network had served their interests by providing an "opportunity to communicate with colleagues" (Katz, McSwiney, & Stroud, 1987, p. 33). When asked what they felt were the best uses of the system, the responses contained two main themes: "providing opportunity for communication with other science teachers who share the same interests and problems; and exchanging ideas and information about teaching materials and strategies as a way of getting 'new ideas'" (p. 33).

Technical Education Research Center [TERC] of Cambridge, Massachusetts has, under various grants, designed and implemented several computer networks that have some characteristics in common with BBSs. The first of these was the National Geographic Society BBS operated between 1985 and 1988. One small part of this service was the ability to allow teachers to communicate with other teachers and with students. File and program sharing was also an important component of the system. TERC learned several important lessons from this initial attempt at developing a computer network. According to Bradsher (1992) "people will use a telecomputing service if it offers something they want at a bargain price" (p. 41).

Bradsher also concluded that "when a service is free, people seem willing to accept some inconvenience" (p. 41). Bradsher also recommended a BBS as a "practical way to promote sharing within a local calling area" (p. 41).

In 1989, TERC and the National Geographic Society established Kids Network under a grant from the National Science Foundation. This project is part of a curriculum project and is open only to selected schools. The system is highly specialized. It uses custom-written software for users and operates on a commercial network. Two conclusions based on TERC's experiences with this project are important to this study. First, software for teachers must be easy to use and participants require some training. Second, many teachers use the system to communicate with other located nearby. This is not economical when users are all communicating through a central mainframe computer located in another part of the country. Teachers within small geographic areas wish to communicate with one another. A local BBS could serve this function in a more cost effective manner than that used in the Kids Network project.

Another student-oriented project that allows teachers to communicate with one another is the Star

Schools Project designed and operated by TERC. This is also a curriculum project funded by the National Science Foundation and run on a mainframe computer. One difference between Kids Network and the Star Schools Project is that the latter encourages teachers to communicate with each other using the network. The main function of the network, however, is to improve middle school science education by using cooperative learning projects coordinated on the network. The TERC staff used teacher questionnaires among other methods to evaluate the effectiveness of the network as a communications tool and found that it "appealed especially to teachers who were more isolated professionally" (Weir, 1992, p. 19).

The most recent TERC project was LabNet. This project operated under a grant from the National Science Foundation between 1989 and 1992. LabNet was designed to assist physics teachers in adopting new methods of teaching physics in secondary school. The project's main goal was "fostering the use of project-enhanced science learning" according to Gal, Lockett, and Parrott (1993, p. 60). Secondary goals were "helping to build a community of practice among teachers" and "motivating and equipping teachers to use microcomputer technology" (p. 60). Communication among teachers was considered a necessary means to the project's main goals.

The project was aimed specifically high school physics physical science teachers. Ruopp and Pfister (1993) describe the communications portion of the project as "the first national network designed for high school teachers of physical science" (p. 3). Participants relied on custom communications software to access the communications system during the first year of operation. In response to user comments and questionnaire data, the project moved to a commercial network in 1990. The new network offered participants access to an on-line bulletin board system. It also allowed participants to use whatever software best suited their requirements. This is the first project cited in which specific mention is made of the desire of participants to select their own software and to access the services of an electronic bulletin board. Questionnaire data was used extensively in evaluating the effectiveness of the system as a means of communication among participants.

Summary

With the exception of the ETC conferencing system (Katz, McSwiney, & Stroud, 1987), all systems described relied on mainframe computers. The success of the ETC project confirms the idea that microcomputers are adequate for a small communications system. Although powerful, mainframes are expensive to operate relegating their use to funded projects or projects that charge a fee for access. Equipment costs are lower than they were when early communications projects were established. With costs declining, communications systems can be economically implemented in small, populous areas. The success of these early projects suggests that teachers are willing and able to communicate electronically and that they gain professionally from such communication.

Given a choice of message areas, participants in the ETC project preferred to communicate with others who teach the same subject. Participants who were isolated from their colleagues were more willing to make use of the system than those who had contact with colleagues. Like the EIES project, the ETC project was successful with a limited number of users from a small geographic area.

Nearly all of the projects described problems participants had using the communications hardware and software. The ETC project and all of the TERC projects were used custom-written telecommunications software to address these problems. Even with custom-written software, participants in these projects expressed difficulties using the systems. Interestingly, TERC's latest project, LabNet, allowed participants to use their own software during its second year of operation.

Methods of evaluating system effectiveness are described in several projects. User surveys and questionnaires produced the most useful results. These were used by Bloom and Rabinowitz in the EIES project and Katz, McSwiney, and Stroud in the ETC project. This study relied on a user survey to obtain participant data. Demographic data and participant opinion data was gathered using a questionnaire as the survey instrument.

III. Design Procedures, and Methodology

Assumptions

As stated in Chapter I, nearly half the high school physics teachers in the United States desire greater professional contact with their colleagues. This desire is at least partially due to the lack of effective means of professional communication among groups of physics teachers. User satisfaction with the target communications system was measured using opinion data. It is assumed that subjects who reported that the system was meeting their professional communications needs were communicating effectively.

To have the greatest effect on the communications needs of a group of physics teachers, the communications system should be used by those who desire greater professional contact with their colleagues. This would include those who have been "drafted" to teach physics but who were trained in a different field and those who consider themselves unqualified or under-qualified to perform their physics teaching assignments. It is assumed that if the system is found effective, those in need of it will elect to use it. Physics teachers who use the system must also have access to required computer hardware and software and the ability to use them with some proficiency. Participation required a minimum level of computer literacy and competence and some desire to participate.

Since the desire for greater professional contact is a national phenomenon among physics teachers, information about the value of the target BBS as a means of professional communication may be useful to organizations of physics teachers wishing to implement similar systems for their members. If the target system is determined to be an effective means of professional communication, the characteristics that make it effective can help organizations offer similar options. If it is not effective, its identified shortcomings will help organizations avoid them. It is assumed, therefore, that the effectiveness of the target system can be used to predict the effectiveness of other, similar systems.

Limitations

Due to the design of the study the experimental group consisted of users of a physics teacher BBS and consisted of 33 members. This number is small compared to the population of physics teachers that was estimated at nearly 18,000 by Neuschatz and Covalt (1988). The experimental group was also from a single, geographic area. The geographic restriction is a result of the way local BBSs operate. While necessary, it limits the study's significance.

To use a BBS, a participant must have had access to a computer and a telephone line. Participants must also have been able to use communications software and to interact with the BBS software. Consequently, members of the experimental group have met these requirements. This may result in a difference in professional characteristics among the experimental and control groups. Even if there is no significant difference in the professional characteristics of the groups, there are other possible differences. Computer literate physics teachers with access to hardware and software may not be representative of all physics teachers. If the bulletin board system is found effective for current users, there is no assurance that other physics teachers would find it effective. The effectiveness of a BBS as a means of professional communication may depend on the personal and professional characteristics of its users.

Membership in the target system was voluntary. Therefore, professional characteristics of the experimental group may differ from those of the control groups. The target BBS was operational when users were surveyed. It was not possible to determine the level of professional communication that existed before the study began. Conclusions based on this study and predictions based on these conclusions are limited by the differences between the experimental and control groups, the questionnaire response rate, and the sizes of the groups involved.

Hypotheses, Null Hypotheses, and Alternatives

For the results of this study to be useful to those desiring to implement similar communications systems, the similarities and differences between the experimental group and other groups of physics teachers must be determined. Physics teachers not using a BBS for communication served as control groups and were surveyed at the same time as the experimental group. Two control groups were used, both consisting of physics teachers from Long Island, New York. This area was chosen because it is geographically well defined and because it has an active physics teacher association willing to cooperate with this project. One control group consisted of members of the Long

Island Physics Teachers Association (LIPTA). The other consisted of physics teachers who were not LIPTA members. When combined, these two groups represent all physics teachers from Long Island, New York. The null hypothesis for this comparison is:

> There are no significant differences between the experimental and control groups when tested for . . .
>
> (a) professional affiliations,
>
> (b) journal reading,
>
> (c) problems facing physics teachers,
>
> (d) professional contacts,
>
> (e) teaching assignments,
>
> (f) background and training, and
>
> (g) school characteristics.

Where differences occurred on individual tests of the null hypothesis they forced the rejection of that portion of the null hypothesis. Characteristics based on rejection of individual tests of the null hypothesis were used to describe the experimental and control populations.

Discussion of Population and Sample

Wood and Blankenhorn (1990) estimated the number of BBSs in the U.S. at more than 16,000. By February 1994, Boardwatch Magazine estimated the total number of public BBSs in North America at 57,000. (J. Rickard, personal electronic communication, February 27, 1994). Wood and Blankenhorn describe the annual turnover in BBSs as enormous and suggest that locating BBSs specializing in specific topics is difficult. When these authors surveyed a list of BBSs maintained by a major modem manufacturer, they found that "most of the lines were either changed, busy, or disconnected" (p. 298). For these reasons, locating possible target systems for this study involved an on-line search of operational BBSs.

The search for a target system for this study began late in 1989. Names and telephone numbers for initial contact BBSs were obtained from popular and professional publications (AAPT, 1988a; and Freitag, 1989), from commercial on-line services (CompuServe), and from electronically-published lists of BBSs (The List). Three BBSs in the United States open primarily to physics teachers were initially located--one in Massachusetts, one in Maryland, and one in Florida.

After locating these BBSs, the system administrators of each were contacted to determine whether the system were still operated primarily for physics teachers. According to its system administrator, the funding source of the Massachusetts BBS recently changed. The BBS is now funded in part by the National Science Foundation. This resulted in a change of emphasis away from physics and toward middle and junior high school science teachers (M. Sternheim, personal communication, October 31, 1989). The system administrators of the Maryland BBS replied that it was also recently restructured. It now functions as a software exchange and a support system for a science education consortium located in the College Park, MD area (J. Wilson & C. Misner, personal communication, November 13, 1989). The BBS in Florida has maintained its function as a system primarily devoted to communication among high school physics teachers, according to its system administrator (J. Howard, personal communication, November 5, 1989). Additional on-line searching during 1990 yielded no additional physics teacher BBSs. After this study was completed, another search for a BBS dedicated to physics teachers was conducted. A description of that search is contained in Appendix B. This second search also discovered no additional physics teacher BBSs operating in the U.S.

The system administrator of the Florida system was then contacted by telephone. The purpose of the study was explained to him and he was asked if he would cooperate with the study. He indicated that individual participation by BBS members was voluntary, but that he would supply a list of names and addresses of registered users. He also indicated that he would assist in any other way that would ensure the success of the study (J. Howard, personal communications, March 18, 1990 through July 15, 1990).

The Florida BBS received some funding for its operation through the University of Central Florida, Orlando. This funding was used by the system administrator to purchase the computer on which the system operates and to supply a group of participants with the software and communications hardware needed to use it. Twenty-five volunteers received telecommunications software and modems to allow them to access the system. A number of others who already had access to the required software and hardware have also been allowed access the system. The number of participants at the time the survey was undertaken was 33 (J. Howard, personal communications, March 18, 1990 through July, 1992). Volunteers from the Florida BBS served as the experimental group for this study.

It is possible that the characteristics of participants differ from those of the physics teacher population due to the size of the experimental group and the nature of the communications medium. Equipment, monetary, and interest restrictions may be determining factors for participation. Physics teachers who are using the target BBS must already have overcome these restrictions in order do so. Identifying commonalities and differences among the experimental and control groups is one of the goals of this study. The degree to which participant characteristics correspond to those of other physics teachers is important. Information about the experimental and control groups was gathered using a survey questionnaire to allow these groups to be compared.

Major Variables and their Treatment

Three research questions were answered during this study, the first being fundamental. The overall success of the system was determined by whether users find it an effective means of professional communication. The effectiveness of the system as judged by its users affects the importance and meaning of the last two questions. System characteristics may be responsible either for its success or failure. If users find the system ineffective, their opinions will be used to determine the reasons for its weaknesses and for user dissatisfaction. Similarly, the characteristics of the user population will be helpful in determining whether the system meets only their needs or could be expected to meet the needs of other physics teachers. Participant opinions were solicited as a major part the study.

There is little statistical information available that can be used to determine what constitutes effective system use. Three projects described in the literature determined the effectiveness of electronic communication by how often it was used by participants (Alaska Department of Education, 1979; Heidelbach, 1984; Schrum, 1988). Of these, none used a statistical method to determine successful use. Instead, high levels of participation were equated with effective use. What constituted high levels of system use and the determination of effectiveness were judgments of the authors. While the authors based their judgments on direct observations and these judgments were probably valid, high system use may not correspond to user satisfaction and determination of what constitutes high levels of participation has not been established.

Three other projects used participant opinions to determine the effectiveness of electronic communication (Reynolds, 1986; Bloom & Rabinowitz, 1985; Katz, McSwiney, & Stroud, 1987). In these projects user satisfaction with the system was measured using survey questionnaires. According to Isaac and Michael (1985), surveys are the most widely used technique in education for the collection of data. The AIP study performed by Neuschatz and Covalt (1988) was also based on survey questionnaires. A survey questionnaire, described in the next section, was used during this study to measure participant satisfaction with the BBS and professional characteristics of participants. Professional characteristics of participants were used to determine who they are, where they are calling from, and how they compare to the Long Island, New York control groups. Personal and employment data was collected along with opinions about the relative strengths and weaknesses of the system using the survey questionnaire. This data was used in answering the last research question. User opinion data gathered by the survey questionnaire was used to answer the first two research questions.

Instrumentation

A survey questionnaire (Appendix-A) was used to collect the data in this study. It was constructed using questions from the American Institute of Physics (AIP) national survey of physics teachers (Neuschatz & Covalt, 1988) and from the Educational Technology Center (ETC) computer conferencing project Third Logon Phone Interview Script (Katz, McSwiney, & Stroud, 1987).

To survey the control groups, the questionnaire was modified by eliminating questions dealing with the BBS since the control groups were not using one. The modified version includes Part I and questions 'a' through 'k' of Part II of the full questionnaire. These deal only with the respondent and his or her school. The questions on the two versions of the questionnaire are identical so that a comparison of the experimental and control groups can be made.

Parts I and II of the questionnaire deal with the respondent the school setting. All questions of Part I and Part II questions 'a' through 'g' were used in the AIP survey. Answers were used to determine whether respondents' desire for increased professional communication is similar to those of the control groups. Question 'h' in Part II was used, with wording differences, in both the AIP and ETC projects. The ETC wording is used in the questionnaire. Question 'k' of Part II was used in the AIP survey. A similar set of questions was used in the ETC interview. The remaining Part II questions were used in the ETC interview.

Opinions about perceived system strengths and weaknesses and the effectiveness of the system as a means of professional communication was determined by Part III of the questionnaire that deals with the bulletin board system itself. All questions in this part were used in the ETC interview. References to science or science teaching were changed so that they refer to physics or physics teaching.

Validity of Instruments

One problem that must be addressed when gathering data by questionnaire is that of response rate. Fowler (1988) states that response rates of 70 percent can be obtained using mail procedures and suggests that obtaining acceptable response rates is easier "if the sample is composed of motivated, well-educated individuals" (p. 55). Response rates of at least 70 percent are considered acceptable.

Another problem is that of question validity and clarity. All questions used in this study were used previously in either the ETC project (Katz, McSwiney, & Stroud, 1987), or the AIP project (Neuschatz & Covalt, 1988). The AIP study questionnaire was designed by AIP staff members with assistance from members of the American Association of Physics Teachers and a member of the Research Triangle Institute, an organization with previous experience in developing questionnaires (Neuschatz & Covalt, 1988). The questionnaire was then pretested on a sample of over 200 physics teachers and revised based on pretest experience and comments from pretest participants. The ETC staff used similar methods to develop survey questions. They also assessed the reliability of their instrument by administering it a second time to a small sample of participants and comparing responses to those obtained in the first administration. The agreement between first and second administration averaged 95 percent.

As an additional determination of question validity, the questionnaire used in this study was pre-tested according to procedures outlined by Isaac and Michael (1985, pp. 135-140). The pre-test group consisted of ten volunteers all of whom were currently teaching physics and were familiar with the use of bulletin board systems. This group found no problems of question clarity or ambiguity. Each test volunteer was able to answer every question with acceptable responses. Comments consisted only of suggestions for format changes that are reflected on the final version (Appendix-A).

Reliability of Instruments

Reliability of the survey questionnaire posed other problems. Re-administering the questionnaire to a small sample of respondents was not necessary. Unlike a test, questionnaires of the type used in this study do not measure acquired knowledge. One part of the questionnaire dealt with factual information about respondents' professional characteristics and working conditions. Questions of this type simply require that respondents answer non-controversial questions in a factual manner. The remainder of the questionnaire administered to the experimental group dealt with opinions and value judgments of respondents. The information supplied by respondents on this section of the questionnaire was used to answer the research questions and to establish the validity of the research hypotheses.

Reliability of the survey questionnaire was estimated using the technique of rational equivalence reliability described by Gay (1992). Coefficient alpha (sometimes referred to as Cronbach's alpha) was used to calculate an estimate of questionnaire reliability. This method of estimating reliability results in a conservative estimate according to Gay. To calculate coefficient alpha, items in check list format were treated as test questions with an affirmative response scored as "correct". This allowed the questionnaire check lists to be treated mathematically as a test. Part II, question 'f', and Part II, question 'k' were treated somewhat differently. Question 'f' choices were scored in ascending order with choice 'none' assigned zero and choice 'very active' assigned four. Question 'k' asks two separate questions. Professional contact is measured by the first three choices and desire for additional contact is measured by the fourth choice. These two questions were treated separately. The first three choices were scored the same as question 'f'; the fourth choice was scored as a separate question. Results are described in Chapter IV.

Sampling

Random selection of participants was not possible because BBS membership was determined by the system administrator before this study began. Membership in the BBS serving as the experimental group for this study was limited to interested physics teachers. Since telephone expenses are the responsibility of the members, most live or work in the region near Orlando (Winter Park), Florida where the BBS hardware is located. This group of participants, then, consists of volunteers interested in using a BBS to communicate with other physics teachers. Using volunteers with a common interest in electronic telecommunication and with some degree of computer literacy introduces bias in the sample. Comparison with another physics teacher groups is, therefore, imperative. The experimental group was compared to the control groups from Long Island, New York to determine whether the experimental group is representative of other groups of physics teachers.

To statistically compare the experimental group in Florida with the control groups in New York, the modified version of the questionnaire described above was administered to the control groups. This version consisted of Part I and questions 'a' through 'k' of Part II of the full questionnaire. The control groups were contacted using two lists. The first list, supplied by the New York State Department of Education, contained the names and school addresses of all teachers of physics on Long Island. The second list contained the names of LIPTA members. The names in the second list were deleted from the first, yielding a list of Long Island physics teachers not belonging to LIPTA. All teachers were contacted.

Data Gathering Techniques

Questionnaires were mailed to all members in each of the three groups. Home and school addresses of the experimental group members were supplied by the BBS system administrator. Only school addresses were available for the control groups. Survey questionnaires were mailed to participants in each group using school addresses. After the initial return, non-respondents were re-contacted by mail using school addresses. A third mailing was made to non-respondents in the experimental group using home addresses.

Statistical Tests and Presentation of Results

The goal of this study is to determine the success of a BBS as a means of professional communication among physics teachers and to describe the characteristics of the system and its users. Questionnaire results were used to make these determinations and comparisons. Responses to Part II questions 'f', 'g', 'h', and 'k' of the questionnaire are in the form of check lists and both experimental and control groups responded to the same lists. Therefore, the groups can be compared for significant differences using a chi-square analysis on each of these sections. Questions in Part I require factual, numeric responses about the respondents' schools. For comparison of control and experimental groups on data in Part I and Part II questions 'a' and 'b', a one-way analysis of variance was used to determine whether responses of the three groups are significantly different. Where significant differences existed, multiple comparison methods were employed. The Scheffe test was the multiple comparison method chosen because, according to Gay (1992), it "is appropriate for making any and all possible comparisons involving a set of means" (p. 439) and because "sample sizes do not have to be equal, as is the case with some multiple comparison methods" (p. 439). All tests were performed at the 5 percent significance level. The volume of data is small enough that results of each statistical test are presented in narrative format.

The remaining data were used for a qualitative comparison of the groups involved. Answers to open-ended questions and opinion data were grouped where possible, but much opinion data is presented in summary form or by citing individual responses. Due to the nature of the questions, opinion data obtained from open-response questions were compared qualitatively. Again, since the number of participants was small, results are presented in a narrative format.

IV. Results

Questionnaire Response Rate

The survey questionnaire was mailed to members of all three groups using school addresses for the first mailing. Approximately three weeks later, returns had stopped. A second mailing was made to those who had not responded to the first mailing. For the second mailing, school addresses were used for all groups. A third mailing was finally made to the experimental group members using home addresses. Group sizes and response rates are presented in Table 1.

Table 1 Questionnaire Response Rate

	Experimental Florida	Control LIPTA	Control No LIPTA
questionnaires mailed	33	92	101
questionnaires returned	25	72	74
response rate	76%	78%	74%

Questionnaire Reliability

As described in Chapter III, reliability of the survey questionnaire was estimated using rational equivalence reliability described by Gay (1992). Coefficient alpha was used to calculate an estimate of questionnaire reliability. Using all questionnaire returns, coefficient alpha was calculated to be 63%. Gay states that for well established instruments such as personality measurements, test reliability coefficients in the 70% to 80% range are acceptable. However, when instruments are developed in new areas "one usually has to settle for lower reliability" (p. 168). Since coefficient alpha yields a conservative estimate of reliability, also according to Gay, the questionnaire has sufficient internal consistency reliability for the purposes of this study.

Questionnaire Results - Part I

Part I of the questionnaire dealt with the respondents' schools. Group mean responses are presented in Table 2. There is no significant difference among the three groups for the number of sections of physics being taught $F(2,168) = 1.99$, $p < .05$ or the number of students enrolled in physics courses $F(2,168) = 2.27$, $p < .05$. When comparing sizes of senior classes, the experimental group had a significantly larger mean class size ($M = 510$) than the

LIPTA control group (M = 299), $F(2,168) = 6.35$, $p < .05$. A significant difference also exists in the mean number of years of science required for graduation, $F(2,168) = 22.14$, $p < .05$. The experimental group mean (M = 2.92) is significantly greater than the LIPTA control group (M = 2.13), $F(2,168) = 22.25$, $p < .05$. and the non-LIPTA control group (M = 2.35), $F(2,168) = 11.39$, $p < .05$. There is no significant difference between control groups, $F(2,168) = 1.80$, $p < .05$.

A similar pattern exists for the number of physics teachers at the respondents' schools. Although there is no significant difference between the control groups, $F(2,168) = 0.91$, $p < .05$, there are significant differences between each of the control groups and the experimental group. The experimental group had a significantly smaller mean number of physics teachers per school (M = 1.36) than the LIPTA control group (M = 2.31), $F(2,168) = 5.92$, $p < .05$ or the non-LIPTA control group (M = 2.68), $F(2,168) = 11.45$, $p < .05$. This is discussed further in Chapter V.

Table 2 Questionnaire Results - Part I

Mean of all responses

	Experimental Florida (n = 25)	Control LIPTA (n = 72)	Control No LIPTA (n = 74)
a. sections of physics taught	4.9	5.1	6.0
b. students enrolled in physics	129	104	131
c. size of senior class	510	299	414
d. years of science required	2.9	2.1	2.4
e. number of physics teachers	1.4	2.3	2.7

Questionnaire Results - Part II

The first section of Part II of the questionnaire (questions 'a' through 'e') deals with respondents' teaching history and assignment. Results are presented in Table 3. Responses to questions 'a' and 'b' are presented as group means; responses to questions 'c', 'd', and 'e' are percent of affirmative responses. There is no significant difference for experienced measured by question 'a', $\underline{F}(2,168) = 2.06$, $\underline{p} < .05$. On question 'b' comparing the number of physics classes respondents currently teach, there is a significant difference among the groups, $\underline{F}(2,168) = 17.36$, $\underline{p} < .05$. For this question, there is no significant difference between the two control groups, $F(2,168) = 0.01$, $p < .05$. The mean number of classes taught by the experimental group ($M = 3.80$) is significantly less than either the LIPTA control group ($M = 2.44$), $F(2,168) = 14.75$, $p < .05$ or the non-LIPTA control group ($M = 2.41$), $F(2,168) = 15.61$, $p < .05$. There were no significant differences among the three groups for questions 'c', 'd', and 'e'.

Table 3 Questionnaire Results - Part II 'a' - 'e'
Mean of all responses ('a' and 'b')
Percent responding yes ('c', 'd', and 'e')

	Experimental Florida (n = 25)	Control LIPTA (n = 72)	Control No LIPTA (n = 74)
a. physics experience	10.7	15.0	13.4
b. physics classes taught	3.8	2.4	2.4
c. degree in physics	36%	61%	50%
d. began career in physics	40%	54%	44%
e. physics for 2/3 of career	64%	72%	64%

Question 'f' of Part II measures respondents' affiliations with six professional organizations. Responses are presented in Table 4. For each organization, two tests were performed to determine whether differences exist among the three groups for affiliation with that organization. For the first set of tests, responses were compared using all levels of affiliation for each organization. For the second set of tests, the last three responses (inactive, somewhat active, and very active) were combined to produce an organization membership. Membership in each organization was then compared. Both tests showed significant differences among the three groups for two of the six organizations. These differences exist for affiliation with the American Association of Physics Teachers (AAPT), chi-square(6, N = 171) = 31.51, p = .05, and the American Federation of Teachers (AFT), chi-square(6, N = 171) = 13.64, p = .05. With respect to AAPT, the non-LIPTA control group had lower membership than either of the other groups. With respect to AFT, the experimental group reported a lower membership than either of the control groups.

Table 4 Questionnaire Results - Part II 'f'

Percent indicating affiliation

	Experimental Florida (n = 25)				Control LIPTA (n = 72)				Control No LIPTA (n = 74)			
	A	B	C	D	A	B	C	D	A	B	C	D
NEA	64	12	20	4	79	10	10	1	81	11	8	0
NSTA	40	16	40	4	49	21	24	7	57	24	14	5
AAPT	36	20	24	20	24	24	35	18	62	11	27	0
NCTM	96	4	0	0	99	1	0	0	97	0	3	0
ACS	80	8	8	4	82	14	1	3	81	8	11	0
AFT	84	8	4	4	43	31	24	3	51	27	19	3

Codes A - none C - somewhat active
B - inactive D - very active

Question 'f' of Part II included space for respondents to list membership in professional organizations not on the check-list. Of the experimental group members who responded to this section, 9 (36%) reported membership in the Florida Association of Science Teachers. Two other organizations were each listed once. Respondents in the first control group (LIPTA members) listed 14 professional organizations. Of these organizations, all except four were named by only one respondent. The four organizations named more than once were: IEEE (2 for 3%), Nassau County Supervisors Association (3 for 4%), Suffolk County Science Teachers Association (8 for 11%), and the Science Teachers Association of New York State (17 for 24%). Respondents in the second control group (non-members) listed 10 professional organizations. Of these, two were named more than once; the IEEE (2 for 3%) and the Science Teachers Association of New York State (4 for 5%). While no statistical analysis was performed on the category "Other Professional Organizations", the organizations listed indicate that the experimental group and the LIPTA control group respondents report a higher level of participation in organizations not listed on the questionnaire than the non-LIPTA control group respondents. In addition, many of the organizations listed by the non-LIPTA control group were not science teaching oriented organizations (e.g. American Heart Association and New York State United Teachers).

Question 'g' of Part II was used to determine publications respondents read regularly. Responses are presented in Table 5. First, all groups were tested against all publications. This test revealed no significant difference (chi-square(14, $\underline{N}$ = 357) = 15.50, $\underline{p}$ = .05). Next, each publication was tested separately. Significant differences were found on two of the publications. These were 'The Science Teacher', chi-square(2, N = 171) = 25.61, p = .05 and 'The Physics Teacher', chi-square(2, N = 171) = 12.99, p = .05 . For both publications the non-LIPTA control group reported lower numbers of regular readers of these publications than either of the other groups.

Table 5 Questionnaire Results - Part II 'g'

Percent indicating publication read regularly

	Experimental Florida (n = 25)	Control LIPTA (n = 72)	Control No LIPTA (n = 74)
Discover	36	32	24
Physics Today	44	44	30
Science	8	8	5
Science Digest	4	1	3
Science News	24	19	14
Scientific American	16	32	35
The Physics Teacher	68	83	43
The Science Teacher	44	21	11

Question 'h' of Part II asked respondents about problems physics teachers face. Responses are presented in Table 6. First, all groups were tested for differences on all problems with no significant difference found, (chi-square(14, N = 357) = 15.50, p = .05). Next, each problem was tested separately. These tests also indicated no significant differences among the three groups on any of the problems.

Table 6 Questionnaire Results - Part II 'h'

Percent indicating problem physics teachers face

	Experimental Florida (n = 25)	Control LIPTA (n = 72)	Control No LIPTA (n = 74)
Keeping up on physics	12	10	14
Keeping up on physics teaching	16	25	24
Student motivation, ability	48	69	65
Student discipline	0	14	11
Lack of colleagues	24	18	8
Low pay	20	6	11
School administration	16	24	19
Lack of time	48	54	38

Question 'h' of Part II also included space for other problems faced by physics teachers. Of the experimental group members who responded to this section, 12 problems were listed with some duplication. These fall into four broad categories (time, money, societal attitudes, and students). Time-related problems included classroom interruptions, lack of student time, lack of preparation time, and lack of time to teach required material. One respondent reported a lack of money for equipment and supplies. The two societal problems were the de-emphasis of physics as an important subject of study, and a low level of societal values causing a lack of interest. Student problems included poor background, poor attitude, and poor problem-solving skills.

Of the LIPTA control group, 42 problems were listed with some duplication. These problems fall into the categories listed above and two additional categories (curriculum, and teacher). Time problems were similar to those listed by the experimental group respondents (too many preparations, insufficient class time, and insufficient preparation time). Money problems included lack of funds for new or replacement equipment and supplies, and lack of funds for a laboratory assistant. Societal problems included problems with guidance departments and school boards regarding the importance of physics as a course of study, poor student and parental attitudes towards classroom attendance, and the lack of societal acceptance of teaching as a profession. Curriculum-related problems included a restrictive syllabus, too much state-required teaching material, and the format of statewide final examinations. Teacher problems included low morale, lack of interest in physics, difficulty in maintaining enthusiasm in teaching, and lack of training in physics.

In the non-LIPTA control group, 26 problems were listed with some duplication. These problems fall into categories listed for the experimental group. Only one time-related problem was listed (insufficient lab time). Money problems included low salaries and the high cost of living for Long Island, NY. A bias against physical sciences was the only societal problem listed. Student problems included poor mathematical skills, poor background, poor thinking skills, and difficulty in convincing students that they can succeed.

Of the three groups of respondents, the LIPTA control group listed far more problems facing physics teachers than either of the other groups. Forty-two problems were reported by respondents. The emphasis for the LIPTA control group's problems were student problems (12 listed) and time and money problems (17 listed). The reasons this group listed many more problems faced by physics teachers than either of the other groups is not obvious. Therefore, the problems are presented above with no additional commentary.

Question 'i' of Part II was an open-response question asking respondents to list sources of teaching ideas they used or found helpful. Responses were grouped into eight categories presented in Table 7. The "conferences" category includes workshops, institutes, and other similar group meetings. In the category "magazines and journals", most respondents who were specific mentioned either "The Physics Teacher" or "The Science Teacher" as the journal that is most helpful. The Long Island respondents who listed a specific professional organization listed the Long Island Physics Teachers Association most frequently. For the category "physics teacher training", the most frequently listed training was the Physics Teacher Resource Agent program operated by the American Association of Physics Teachers.

Table 7 Questionnaire Results - Part II 'i'

Percent listing sources of teaching ideas

	Experimental Florida (n = 25)	Control LIPTA (n = 72)	Control No LIPTA (n = 74)
Conferences	80	61	28
Magazines and journals	28	53	28
Media (videotapes and television)	0	6	3
Local Professional organizations	0	17	5
Physics teacher training	20	7	9
Books	32	18	18
College courses	16	3	12
Colleagues	36	24	35

Question 'j' of Part II was an open-response question asking respondents to list sources of information about ongoing developments in physics they have found helpful. Responses to this question were more diverse in nature than those of question 'i' above. The four categories that were listed by the greatest number of respondents are presented along with the category "miscellaneous" in Table 8.

The category "conferences" includes workshops and other group meetings. In the category "local professional meetings", those held by the Long Island

Physics Teachers Association were mentioned most frequently by respondents in the two control groups. The Florida Association of Science Teachers meetings were listed most frequently by respondents in the experimental group. "Physics Today" is a monthly journal of physics news and commentary published by the American Institute of Physics. Newspapers were mentioned by many respondents in the two control groups. Most of those who listed newspapers as a source of information on developments in physics specifically named the "Science Times" section of the "New York Times". This would explain why no members of the control group listed newspapers as sources, since the newspaper mentioned most frequently is published in New York City. Under the category "miscellaneous" were several sources of information including literature, part time work at Brookhaven National Laboratories, science museums, books, university courses, and the American Association of Physics Teachers. None of these sources was listed by more than four respondents.

Table 8 Questionnaire Results - Part II 'j'

Percent listing sources of developments in physics

	Experimental Florida (n = 25)	Control LIPTA (n = 72)	Control No LIPTA (n = 74)
Conferences	28	29	9
"Physics Today"	88	51	55
Local professional meetings	20	14	3
Newspapers	0	18	26
Miscellaneous	8	15	9

Question 'k' of Part II was used to determine two different pieces of information relating to respondents' contacts with professional colleagues. For each category of colleague, contact was determined using the first three response choices (none, some, frequent). Then, the last response choice was used to determine whether respondents desired more contact with that category of colleague. Responses are listed in Table 9a and Table 9b. The groups were compared for contact with each category of colleague. Significant differences were found for the categories "physics or other science teachers at other schools", chi-square(4, N = 171) = 37.56, p = .05 and "college/university faculty", chi-square(4, N = 171) = 18.36, p = .05. For each of these categories, the experimental group reported the greatest amount of contact and the non-LIPTA control group reported the least amount of contact.

The groups were tested to determine differences in desire for additional contact with colleagues. These tests indicated no significant differences among the three groups on any of the categories tested. Test results are: 'teachers - your school', chi-square(2, N = 171) = 0.81, p = .05; 'teachers - other schools', chi-square(2, N = 171) = 0.85, p = .05; 'college faculty', chi-square(2, N = 171) = 0.83, p = .05; 'scientists', chi-square(2, N = 171) = 0.66, p = .05.

Table 9a Questionnaire Results - Part II 'k'

Percent indicating of contact with colleagues

	Experimental Florida (n = 25)			Control LIPTA (n = 72)			Control No LIPTA (n = 74)		
	A	B	C	A	B	C	A	B	C
Teachers - your school	28	28	44	18	29	53	27	24	49
Teachers - other schools	12	52	36	24	67	10	54	43	3
College faculty	36	40	24	50	39	11	76	16	8
Scientists	72	24	4	69	25	6	84	11	5

Codes A - none B - some C - frequent

Table 9b Questionnaire Results - Part II 'k'

Percent indicating desire for additional contact

	Experimental Florida (n = 25)	Control LIPTA (n = 72)	Control No LIPTA (n = 74)
Teachers - your school	12	13	8
Teachers - other schools	20	22	16
College faculty	20	18	14
Scientists	20	17	14

Questionnaire Results - Part III

Question 'a' of Part III was used to determine what types of computer familiarity experimental group members had before joining the BBS. Responses are presented in Table 10. The lowest level of familiarity was with the use of modems for communication and for file transfer. Six respondents listed computer familiarity under the category "other". Two stated that they used scientific software. The other four items listed were programming, graphics, appleworks, and home budgeting/financing.

Table 10 Questionnaire Results - Part III 'a'

Number indicating computer familiarity (n = 25)

	personally familiar	taught children	taught adults
Modem use	8	1	1
uploading / downloading	7	1	1
Word processing	23	5	5
Logo or other programming	11	2	2
Computer as a measuring tool	18	4	1
Spreadsheets / databases	20	2	2
Other Educational software	19	2	0

Question 'b' of Part III ("What do you have to do to get ready to log onto the system?") was answered by 16 respondents. Of these, 12 indicated that logging onto the system was routine. Responses included "read instructions", "enter password", "load communications software", "nothing special", etc. Three respondents indicated that they must use a computer at home and that it was somewhat inconvenient.

Question 'c' of Part III ("When you log onto the system, what do you usually do first?") was answered by 13 respondents. Eight stated that they first read mail and messages, one left messages first. One said that the question could not be answered since each logon was different. The remaining three stated that they "explored the system" or "chose a selection from the on-line menu".

Question 'd' of Part III asked respondents where they had access to a phone line for modem use. Sixteen indicated that the modem phone line was at home, seven that it was at school, and two had modem phone lines in both locations.

The results of Part III questions 'e' through 'n' are presented in Table 11.

Table 11 Questionnaire Results - Part III 'e' - 'n'

Number indicating yes or no (n = 25)

	yes	no
e. Easy to get to the phone?	18	5
f. Wait for phone line?	4	20
g. Leave your computer/modem set up?	14	11
h. Hard to find time?	11	13
i. Personal phone costs?	7	17
j. Phone costs affect use?	4	20
k. Save messages to disk?	7	18
l. Upload?	10	14
m. Used the message editing?	7	18
n. Extended discussions?	2	22

Question 'o' of Part III was used to determine what types of problems users had when they were getting started using the BBS. Responses are presented in Table 12. Under the category "Other", one respondent wrote that the system was too slow responding to commands, one wrote that set-up of the computer (configuring hardware and software) was a problem. One stated that the wrong software was installed initially and that this lead to several problems.

Table 12 Questionnaire Results - Part III 'o'

	Number indicating problems getting started (n = 25)
Selecting / obtaining hardware	3
Telephone system	3
Selecting / obtaining software	5
Get busy signal often when calling	7
Using communications software	5
Using the system software	2

Question 'p' of Part III was used to determine what types of assistance were helpful to respondents when they encountered problems getting started using the BBS. Responses are presented in Table 13. Under the category "Other", one respondent stated that prior experience with telecommunications was essential to success and another stated that friends had helped with initial problems.

Table 13 Questionnaire Results - Part III 'p'

Number indicating sources of help (n = 25)

Attended training session	13
Talked to other users	8
Called for (voice) help	13
Talked to computer people at school	0
The system manual	13
Posted questions on the system	2

Question 'q' of Part III was an open-response question asking respondents to list their suggestions for improvement of user training. One respondent suggested group meetings after hardware and software were installed and configured. One stated that one-on-one training was essential to answer questions and deal with problems specific to the individual user. One suggested that training should include physically opening the user's computer and installing hardware. One suggested that training sessions were needed. It should be noted that training was available, but that all users were not aware of this. Three respondents suggested making available specific instructions for transferring files between the user's computer and the BBS. Two stated that no improvement was needed. One user suggested a phone-in help system while another suggested a fax-in system whereby users could receive answers to specific questions. Finally, one respondent suggested that an on-line tutorial would help.

The first part of Part III question 'r' asked respondents if they got to know anyone by interacting with them or by reading their messages on the system. Only five people responded to this question. Two responded no, one said that he or she knew all the other members of the system before signing on, and two responded yes. The second part of the question asked if the respondent had face-to-face contacts or activities with other members of the BBS. There were no responses to this part.

Part III question 's' asked respondents if they got any teaching ideas, new information or updates on materials while using the system and if so whether they made use of them. Three respondents mentioned that they obtained sets of test questions and used them in their classes. One stated that messages were informative and useful, although specifics were not given. Four respondents replied "yes" but did not elaborate. Two responses were "no".

Question 't' of Part III asked respondents how BBSs can help physics teachers and what the best uses of the system were for physics teachers. Five responded that a BBS can help physics teachers by allowing them to share resources (labs, test, problem sets). Four said that to be truly useful the system needed to expand to include a larger base of physics teachers. Three stated that a BBS can be used as a means of passing along physics related information to other physics teachers. One specified reading and exchanging messages as a good use of the BBS and two others gave similar answers specifically citing contact with colleagues as important. Two suggested that exchange of data from student laboratory investigations was a task that the system could be used for allowing either laboratory collaboration among classes or competitions between schools. The remaining positive responses included keeping current, sharing and exchanging ideas, spreading and receiving news related to physics teaching, and finding other physics teachers who can answer physics-related questions. Two users said that there was no benefit to physics teachers. One elaborated that newsletters and a distributed fax system was probably a more appropriate method of information sharing.

Question 'u' of Part III asked respondents what problems do they saw with bulletin board systems and physics teachers. The answers were varied. Five stated that there is not enough time to do all the things required of a physics teacher and also make effective use of a BBS. Three said that the system was too difficult to use and, therefore, that it was not used effectively. Three responded that communicating publicly made them fearful or uncomfortable. One of these elaborated that public communication could be seen as advertising ones ignorance making questions difficult both to ask and to answer. Several others found problems with the system itself. Two stated that data transfer was difficult or inconsistent, three stated that telephone expenses were too great to offset the benefits of using the system regularly, and one stated that the system was too slow making it frustrating to use. Two respondents stated that there were not enough people regularly using the system or that there was not enough message traffic to make the system as useful as it could be. One of these suggested that the system be expanded to cover a larger geographic area. Two people suggested that the system should be broader in scope allowing participation by teachers of other subjects. Finally, three people commented on the inadequacy of their own equipment, stating that it was difficult to use the system with poor equipment.

Question 'v' of Part III asked respondents how the system has served or not served their interests as a physics teachers. Three responded that they no longer used the system. One of these elaborated that his interest had "fizzled" after being enthusiastic for some time. Five stated that since there were not enough regular users the system did not serve their needs as well as it could. Three users responded that because of high costs they did not use the system as much as they wished. Two users complained that the system had some bugs that made it difficult to use effectively. Two others made negative statements about the system's menu structure. One claimed it was difficult to navigate and the other stated that it lacked consistency. Both stated that these problems made the system more difficult than necessary to use. One respondent stated that, since he or she was personally acquainted with nearly all of the system users, telephone conversations were more effective as a means of communication. Two users responded that they had difficulty transferring files between their own computer and the BBS. One elaborated that this turned the system into a message board and reduced its usefulness. Three users stated that, although the information they received from the system was useful, the addition of announcements of statewide activities and state-related information would improve effectiveness. Three users cited test questions as examples of the way the system served their needs. Finally, two users responded that they had received useful information from the system but did not elaborate.

Question 'w' of Part III asked respondents for other suggestions or opinions about the system. Three responded that more physics teachers on the system would be an improvement. Two were less specific stating only that more users would be better even if they were not physics teachers. Three suggested that the system should be more widely advertised. Four users stated that more funding of users was needed. Three stated that more instruction on using the system was needed so that it was easier for new members to use. Two others stated that tutorials or educational sections should be added to the BBS. Three users stated that users needed to share more or more openly with each other. One respondent stated that he or she was no longer able to use the system and missed it.

One person responded that a newsletter or distributed fax system should replace the BBS. Finally, five users stated that no changes were necessary.

Research Questions

Part III of the questionnaire measured only responses by the experimental group. Questions in this part are used to answer the research questions. The first research question asks whether the system under investigation is effective in allowing and encouraging physics teachers to communicate with one another. Part III questions 'r', 's', 't', and 'v' can be used to answer this question. Question 'r' asked respondents if they got to know anyone by interacting with them or by reading their messages on the system. It received only five responses split equally between yes and no with one person stating that his or her circumstances made the question unimportant. Certainly, respondents did not use the system primarily to get to know other physics teachers. Question 's' asked respondents if they got any teaching ideas, new information, or updates of materials while using the system. The response rate here was higher than it was to question 'r' but the results are still not positive. Although eight of the ten responses to the question were positive, only ten of twenty-five group members responded. Participants were more likely to use the system to acquire classroom teaching ideas than to get to know others.

Unlike questions 'r' and 's', question 't' asked for opinions on how a BBS can help physics teachers and what the best uses of the system are. Here respondents were asked to report on their perceptions of the potential uses of the BBS rather than on their experiences with it. Response rate was quite high with twenty of twenty-five respondents answering this question. Of these, only three stated that a BBS provided no benefit to physics teachers or that a BBS is not an appropriate vehicle for information exchange. The remaining seventeen stated that sharing of resources and information, communicating with colleagues, and collaboration were ways a BBS can help physics teachers. Two things are important to note. First, only two responses included specific reference to contact with colleagues. Second, the high response rate indicates that although teachers in the experimental group do not benefit appreciably from use of the BBS, many see the potential benefits of using a BBS as a means of professional communication. This is in agreement with the results of the early pilot project in Virginia portray by Camp (1987) and described in Chapter II. One conclusion made by Camp was that the Virginia project represented a new direction in teacher communication even though it had not met the immediate needs of the community for which it was designed. Camp and the participants in the Virginia project saw the potential of electronic communications but failed to gain adequate benefit from its use. The same seems to be the case with the BBS in this study. Participants see it as a potentially-useful communication tool with specific benefits, but they report having availed themselves of only a few of those benefits. That this situation of perceived but unfulfilled potential exists after more than six years of effort to make electronic communications systems available to teachers suggests that the BBS is not as effective a means of professional communication as once believed.

Question 'v' asked respondents how the system has served or not served their interests as a physics teachers. Nearly every respondent answered this question, with some supplying multiple responses. Of the twenty-six statements received, eight were positive. Three of these were accompanied by suggestions for increased effectiveness. Of the positive responses, none stated that increased professional communication had served their needs.

Considering the responses to questions 'r', 's', 't', and 'v', it is evident that the BBS used for this study is not effective in allowing and encouraging physics teachers to communicate with one another. While users see the potential benefits of a BBS as a means of professional communication according to the results of question 't', the results of questions 'r', 's', and 'v' indicate that the BBS is not functioning in a way that achieves that potential.

The second research question asks what characteristics of the system make it effective or inhibit its effectiveness. The negative responses to question 'v' are helpful here. Three respondents indicated that they no longer used the system but did not give reasons why. Many of the remaining negative responses indicated that users found the system difficult to use. Difficulties included bugs in the system, problems navigating the menu structure, and problems transferring files. Three respondents cited high costs as a problem because costs limited their access to it. The most frequent negative response was that there were not enough regular users of the system.

Question 'u' asked respondents to list problems they saw with bulletin board systems. Twenty four responses were received. The problems listed are similar to those reported in question 'v'. Six responses listed problems with the system including difficulty in using it, problems with file transfer, and slow response. Three users responded that they had trouble with their own equipment making system access difficult. Three other users cited costs as prohibitive. Four users stated that there were not enough regular users to make the system as valuable as it could be with three suggesting that the system be expanded either in geographic area or in membership. Five respondents stated that they could not find the time to access the system as often as they would like. Finally, three users stated that they were uncomfortable with public communication.

The final question asked for suggestions or opinions about the BBS. There were many responses to this question with several respondents contributing multiple suggestions or comments. Only five users suggested that no changes were needed. The other responses closely match the problems described above. Eleven respondents suggested that additional sharing by current users, or an increase in the number of users would improve the system. Four stated that more money was needed either in the form of direct funding or to cover telephone expenses, and five suggested more help or instruction in system use. Taken together, the responses to questions 'u', 'v', and 'w' can be used to answer the second research question. The characteristics that inhibit the system's effectiveness are: a small user base, difficulty in using the system, prohibitive costs, and time constraints.

Questions 'a' through n of Part III can be used to determine characteristics of the system that inhibit its effectiveness as well as to provide the professional characteristics needed to answer the last research question. Question 'a' asked respondents to indicate computer experience before using the BBS. Nearly all had experience with word processing, spreadsheets, databases, educational software, and use of computers as measurement tools. Less than half of the respondents reported having experience with programming, and less than one-third indicated experience with using modems. Participants are experienced computer users, but not experienced modem users. This lack of prior experience with telecommunications can explain some of the problems reported with using the BBS.

Questions 'b' and 'c' asked about logging onto the BBS. Most responses indicated that the log-on process was routine. The only exception being that three users found it inconvenient to use a computer at home to access the BBS. Question 'd' asked where phone lines were located. Most users had phone lines available at their homes. Questions 'e' through 'n' dealt with telephone connections and the mechanics of system use. Most respondents had access to a phone line and did not have to wait to use it. Fifty-six percent of the users stated that their computer and modem were set up and ready to use. While this number is high, it indicates that forty-four percent needed to perform an extra step to access the BBS. More than half of the respondents reported that finding time to use the BBS was difficult, but only twenty-eight percent incurred personal telephone costs and only twenty percent reported that telephone costs affected their use of the system. The responses to questions 'k' through 'n' indicate that less than half the users succeeded in saving messages, uploading files, or editing messages while using the system and that very few became involved in extended discussions with other users.

According to the results summarized above, respondents can be characterized as experienced computer users, but not experienced modems users. Most had little trouble logging onto the system and did so from their homes. Telephone expenses were not a deterrent to system use for the majority of respondents. Many had to connect to the telephone line before using the BBS but most had access to a telephone line and did not have to wait to use it. A relatively small number of users reported success saving messages, uploading files, or editing messages and few became involved in extended discussions. From this information it can be concluded that general computer experience is not necessarily a good predictor of BBS use.

Respondents comments regarding difficulty using the BBS are repeated in their lack of success with saving messages, uploading files, and editing messages. Lack of experience may be the cause of these difficulties, or the skills required may be more difficult than those required for general computer use. Either way, it is apparent that respondents found the bulletin board system difficult to use effectively. Although respondents generally had access to telephone lines and reported little trouble connecting to the system, a combination of smaller problems such as the need to connect to a telephone line for each BBS call, telephone costs, and a lack of time may have combined to make access to the system less than convenient.

Questions 'o', 'p', and 'q' dealt with problems getting started and with user training and assistance. Few respondents reported having any of the problems listed in question 'o'. It is evident that getting ready to start using the system was not considered a difficult task by most respondents. Of the sources of help listed in question 'p', three were accessed most frequently. Approximately half of the respondents attended a training session, telephoned the system administrator for voice help, or used the system manual. Suggestions for improving user training were made in response to question 'p'. Ten respondents suggested ways to improve training. The list of suggestions included either personal assistance or training after users were able to connect to the system. Suggestions for personal assistance were made by respondents who had specific problems they found difficult to solve and that discouraged them from accessing the BBS. Those suggesting that training was needed after users were able to connect to the system included requests for help with specific topics, especially file transfers. From the number of comments made by respondents about difficulties with file transfer, it is evident that this operation was one of the most difficult tasks for them to perform.

V. Discussion, Implications, and Conclusions

As stated in Chapter I, the purpose of this study was to determine the effectiveness of a BBS as a means of professional communication among physics teachers. To make this determination, an experimental group consisting of physics teachers using a bulletin board system was surveyed. As a control, two groups of physics teachers not using a BBS were also surveyed. One control group consisted of physics teachers who were members of a regional physics teachers association. The other consisted of non-members who teach in the same region. Several characteristics of the three groups were compared including background and training, teaching assignments, professional affiliations, journal reading, problems facing physics teachers, and professional contacts. Data and results of statistical tests are presented in Chapter IV.

Discussion of Questionnaire Results - Part I

When comparing schools in which respondents teach, several similarities and differences were encountered. No significant differences existed among the three groups when tested for number of sections of physics taught and number of students enrolled in physics at the respondents schools. This implies that the average size of a physics class is similar among the three groups. A significant difference was found in the number of years required for graduation among the three groups. Teachers in the experimental group all teach in Florida while those in the control groups teach in New York. Differences in the state requirements for graduation are most likely responsible for the larger number of years of science required for graduation reported by the experimental group.

Another statistically significant difference encountered in Part I of the questionnaire was in the number of physics teachers at the respondents schools. The number reported by the experimental group was significantly smaller than either of the control groups. This can be explained by a difference in the number of physics classes taught by respondents. Members of the experimental group reported significantly larger number of physics classes taught than either of the control groups. With the number of sections of physics offered in respondents' schools approximately equal among the three groups and the average number of sections per respondent higher for the experimental group, the number of physics teachers per school is correspondingly lower. The smaller average number of physics teachers per school in the experimental group is an indication that these teachers are more isolated than respondents in either of the control groups. It also indicates that members of the experimental group are somewhat more likely to specialize in teaching physics than members of the control groups.

Discussion of Questionnaire Results - Part II

When examining Part II questions 'a' through 'e', the only significant difference among the three groups is in the number of physics classes taught. This difference has already been discussed. In the areas where no significant differences exist, descriptive comparisons between survey respondents and the United States physics teaching community described by Neuschatz and Covalt (1988) in the AIP survey can be made. The AIP survey reported an average of ten years of physics teaching experience. Respondents in this survey reported a somewhat higher number of nearly fourteen years. There is a larger difference between this survey and the national survey when comparing the number of teachers who have a degree in physics.

According to the Neuschatz and Covalt, nationally, "only about one fourth of the respondents . . . appear to have actually earned a degree in physics" (p. 16). More than half the respondents to this survey reported having a degree in physics. A similar difference exists when examining the number of respondents who began their careers as physics teachers. Neuschatz and Covalt report that 30 percent of physics teachers nationwide began their careers as physics teachers while the respondents of this survey reported that 48 percent had done so.

In the AIP report, schools of all school sizes were examined. Neuschatz and Covalt (1988) used senior class size to quantify school size. Using their parameters, all three groups in this survey reported average school sizes that would be considered large even though the LIPTA control group reported a significantly smaller average senior class size than either the non-LIPTA control or the experimental group. The results of this survey, then, are representative of teachers in large schools. Neuschatz and Covalt reported that large schools tend to employ teachers who have somewhat more experience than smaller schools and that "teachers who earned a degree in physics . . . tend to be overrepresented in the larger schools"

(p. 16). Differences in experience, number who earned physics degrees, and number who began their careers as physics teachers between study and the AIP survey are a result of differences in average school size. Survey respondents are representative of physics teachers nationally when school size is taken into account.

Question 'f' of Part II measured respondents' affiliation with professional organizations. As reported in Chapter IV, two significant differences were found. The experimental group reported a lower rate of affiliation with the American Federation of Teachers (AFT) than either of the control groups. This could be a result of regional or state-wide differences among the groups especially since the New York State United Teachers, is an affiliate of the AFT. Affiliation with the American Association of Physics Teachers (AAPT) also showed a significant difference among the three groups with the non-LIPTA control group reporting a lower membership rate than either of the other groups. The non-LIPTA control group shows a rate of affiliation with AAPT nearly the same as that of the AIP national survey as reported by Neuschatz and Covalt (1988). This indicates that affiliation is greater for the experimental group and the LIPTA control group than is the national average. The only other group for which the rate of affiliation was different for respondents to this survey and the AIP survey is the American Chemical Society (ACS). Nationally, six percent of physics teachers reported affiliation with the ACS. Respondents to this survey reported an affiliation rate of eighteen percent. Although all respondents teach physics, some are primarily teachers of other subjects, especially chemistry.

Part II question 'g' asked respondents to indicate which publications they regularly read. Significant differences existed for two of the eight publications listed. These differences were for The Physics Teacher and The Science Teacher. For both publications the non-LIPTA control group reported a significantly lower percentage of readers than either of the other groups. Differences for The Physics Teacher are not difficult to explain since it is published by the AAPT and the non-LIPTA control group indicated a significantly lower AAPT membership rate than either of the other groups. When compared to the AIP results, the non-LIPTA control group is closer in readership to the national figures than either of the other groups, both of which showed higher rates of regular readership than the national average. For The Science Teacher the results are reversed. The experimental group and the LIPTA control group closely approximate the AIP results while the non-LIPTA control group reported a lower rate of readership. For the other publications listed comparison with the AIP results were mixed. Respondents to the AIP survey reported higher readership rates for Science, Science Digest, Discover, and Scientific American than respondents to this survey. Respondents to the AIP survey reported lower readership rates than respondents to this survey for Physics Today. The two surveys showed approximately equal results for Science News.

Part II question 'h' asked respondents to indicate which problems physics teachers face. As stated in Chapter III, no significant differences were found among the tree groups in this study. However, many more problems were listed by LIPTA control group respondents under the category "other" than either of the other two groups. It is possible that those who see many problems are inclined to join local physics teacher associations in response. But, it is also possible that communication among physics teachers causes them to perceive more situations as problems.

Neuschatz and Covalt (1988) reported six problems that stood out as being cited most frequently by respondents to the AIP survey. Only two of the problems named in the AIP survey were also cited frequently in this survey. One was the perceived lack of student motivation and preparation, cited by 64 percent of the respondents in this survey and by 81 percent of the respondents to the AIP survey. The other problem was a lack of time, cited by 46 percent of the respondents in this survey as and by 71 percent of the respondents to the AIP survey. The most frequently identified problems in the AIP survey were insufficient funds for equipment and supplies followed by inadequate laboratory facilities. Both of these problems were listed under "other" by each of the groups in this study, but with far lower frequency than in the AIP survey. The final, difference between the two surveys was the problem of inadequate access to computers. This was listed as a problem by 62 percent of the AIP survey respondents, but was listed by only a small number of respondents to this survey. It is possible that physics teachers in the three groups of this survey have adequate access to computers or that they do not see lack of access as a serious problem. Since the AIP study was published in 1988, another possibility is that access to computers has changed between the time the AIP did its survey and the time this survey was made.

Questions 'i' and 'j' of Part II were open response questions that asked respondents to list sources of ideas and information. Sources of teaching ideas were listed in question 'i', and sources of information about ongoing developments in physics were listed in question 'j'. Physics teachers who responded to the AIP national survey (Neuschatz & Covalt, 1988) cited "scientific journals (79%) and mass media (70%)" as their primary sources for information on developments in physics and teaching ideas (p. 27). The numbers for this survey were approximately equal for scientific journals, but somewhat lower for mass media. Neuschatz and Covalt stated that about 70 percent listed meetings and conferences as sources of information, approximately equal to the results obtained in this study. The AIP report did not make specific mention of local professional organizations and their meetings as separate categories. These were named frequently by respondents to this survey as sources of both ideas and information.

Question 'k' of Part II was used to supply two pieces of information. It was first used to determine the degree of contact respondents had with colleagues in four different categories. It was then used to determine the degree to which respondents desired more contact with colleagues in each of the same categories. No significant differences were found for contact with science teachers at the respondents' schools or for contact with industrial or research scientists. Significant differences were found for contact with science teachers at other schools and for college or university faculty. For these two categories the experimental group reported the greatest amount of contact while the non-LIPTA control group reported the least amount of contact. This could be a result of the use of the BBS by experimental group members, or it could be a situation that existed before the BBS became operational. Since participation in the BBS was restricted to high school physics teachers, it is unlikely that the BBS had any effect on contact between experimental group members and college or university faculty.

The results of question 'k' were compared with the results presented by Neuschatz and Covalt (1988) in the AIP report. A chi-square test was performed for each group of respondents for each category of colleague using AIP data as the expected values. There were no significant differences between the LIPTA control group and the AIP survey data. LIPTA control group test results were: 'teachers - your school', chi-square(2, N = 72) = 0.13, p = .05; 'teachers - other schools', chi-square(2, N = 72) = 0.08, p = .05; 'college faculty', chi-square(2, N = 72) = 3.61, p = .05; 'scientists', chi-square(2, N = 72) = 2.23, p = .05.

The non-LIPTA control group data were significantly different than the AIP data for three of the four categories. These were: 'teachers - other schools', chi-square(2, N = 74) = 32.12, p = .05; 'college faculty', chi-square(2, N = 74) = 39.57, p = .05; and 'scientists', chi-square(2, N = 74) = 7.66, p = .05. For each of these categories, the non-LIPTA control group reported lower contact with colleagues than the AIP report. There was no significant difference for the category 'teachers - your school', chi-square(2, N = 74) = 4.73, p = .05.

When comparing the experimental group with the AIP survey data, three of the categories showed no significant differences. These were: 'teachers - your school', chi-square(2, N = 25) = 2.68, p = .05; 'college faculty', chi-square(2, N = 25) = 3.79, p = .05; and 'scientists', chi-square(2, N = 25) = 0.05, p = .05. There was a significant difference found for 'teachers - other schools', chi-square(2, N = 25) = 14.06, p = .05. The experimental group reported more contact with science teachers at other schools than the national survey. The difference in reported contact between the experimental group and the AIP data could be a result of the use of the BBS by experimental group members or a situation that existed before the BBS became operational.

The second part of question 'k' asked respondents to indicate whether they desired more contact with each category of colleagues. Results were compared with the AIP data using a chi-square test for each group of respondents for each category of colleague. The AIP data was used as the expected value for these tests. None of the groups in this study reported a desire for more contact with science colleagues at their own school that differed significantly from the AIP results: experimental group, chi-square(1, N = 25) = 0.30, p = .05; LIPTA control group, chi-square(1, N = 72) = 0.43, p = .05; non-LIPTA control group, chi-square(1, N = 74) = 1.71, p = .05.

In all other categories there was a significant difference between the respondents to this study and the AIP survey. For the teachers at other schools, the results were: experimental group, chi-square(1, N = 25) = 58.4, p = .05; LIPTA control group, chi-square(1, N = 72) = 14.40, p = .05; and non-LIPTA control group, chi-square(1, N = 74) = 24.12, p = .05. For college and university faculty, the results were: experimental group, chi-square(1, _N_ = 25) = 5.84, _p_ = .05; LIPTA control group, chi-square(1, _N_ = 72) = 20.31, _p_ = .05; and non-LIPTA control group, chi-square(1, _N_ = 74) = 28.93, _p_ = .05. For scientists, the results were: experimental group, chi-square(1, _N_ = 25) = 7.85, _p_ = .05; LIPTA control group, chi-square(1, _N_ = 72) = 29.41, _p_ = .05; and non-LIPTA control group, chi-square(1, _N_ = 74) = 36.57, _p_ = .05. In all cases respondents indicated a lower desire for more contact than the national average. The lower desire for additional professional contact with physics colleagues outside respondents' schools is probably not the result of BBS usage by the experimental group since all three groups had similar results.

Implications and Conclusions

Although the physics teachers who participated in this study expressed positive opinions about the potential benefits of the use of the BBS as a means of professional communication, their use of the system indicates that it was not successful in meeting the needs of most of them. Several reasons for this lack of success were suggested by the participants.

Participants stated that there were not enough physics teachers using the system to make it as valuable as it could have been. Several suggested that additional users would enhance the BBS's effectiveness. Two suggestions as to how this could be accomplished were made. One was to include teachers of subjects other than physics in the membership. The other was to increase the geographic area over which the BBS operates to increase the number of physics teachers on the system. Each of these suggestions brings with it other problems.

If membership is expanded to include teachers of subjects other than physics, interaction on the system will no longer be uniquely related to physics teaching. Communication with other teachers is not the problem specifically addressed by this BBS. Instead it is operated solely to allow physics teachers to communicate with each other. Inclusion of teachers of other subjects would tend to expand the topics of communication beyond physics and make use of the BBS by physics teachers less desirable. If the geographic area over which the BBS operates is increased so that more physics teachers are included as users, telephone costs would be high for users who are located far from the BBS. Costs were named by several users as a reason for low use of the BBS. This problem would increase for users who incur larger telephone costs than current members. Since some potential users do not have access to a computer equipped with a modem and connected to a telephone line. Decreases in cost of equipment and telephone usage could increase the number of users located near the BBS to access it and become active members.

The other major problem participants reported was difficulty in using the system. This problem is not unique to the BBS studied here. According to Ruopp and Pfister (1993), "Telecommunication is in its infancy. Both current hardware and software are crude instruments of communication" (p. 3). This observation was repeated by Hunter (1992) who declared that "currently available computer software that enables a person to interact on the networks is difficult to learn and use" (p. 10).

Referring to the LabNet project, a national communications project funded by the National Science Foundation and designed and operated by TERC in Massachusetts, Ruopp and Pfister stated that into the second year of operation users were still "having difficulty gaining access to the hardware needed to run the telecommunication software we had provided" and that "even after obtaining the requisite hardware, they still often had problems using the software" (p. 6). The software referred to was custom-written to make it as easy to use as possible. Also referring to the LabNet project, Gal, Lockett, and Parrott (1993) reported that "overwhelmingly, nonusing teachers cited technical problems or lack of equipment" as reasons they did not access the system (p. 77). Ruopp and Pfister also found that "the network's structure discouraged users" (p. 6).

Difficulty of use, in addition to being a problem in itself for users also has cost implications. A system user who is having trouble learning to use communications software will spend more time connected to the system and incur higher telephone bills than necessary. Referring to telecommunications, Drayton (1993) claims that "even a teacher who has used computer applications . . . might easily require 3 to 5 hours to get used to the features of a new system" (p. 156). When users access telecommunications systems infrequently, they have the problem of forgetting what they have learned between sessions. "Thus, each infrequent session is likely to feel like a cold start, until the teacher realizes that more frequent use is an important element of efficiency" (Dayton, p. 156).

Time is also a problem faced by BBS users. Whether the system is used during the school day or at home, time must be found to do so. Time must also be found to learn to use the hardware and software required for BBS access. Time problems were examined during the Star Schools project. Some who signed on to the project decided not to participate. When asked why, approximately half "reported that lack of time was the primary reason" (Weir, 1992, p. 18). Describing the criteria required for successful operation of an educational telecommunications system, Weir claims that "teachers do not have the time to mess around with baroque configurations that break down, take time, and demand attention" (p. 18).

Participants in this study expressed a positive opinion of the potential of using the BBS to communicate with other physics teachers. However, the potential to serve as a means of professional communication is not being fulfilled by the BBS under study. Drayton (1993) expressed similar opinions, claiming that "the attractive possibilities, however, often remain possibilities only, because of logistical or administrative constraints, or because of limitations of current hardware and software" (p. 145)

The reasons for the lack of success of the BBS under study in this project are a set of problems common to many computer communications projects. These include time, difficulty of use, and costs. Perhaps difficulties would be overcome if BBS users had a compelling reason to communicate with each other or use the system for other purposes. Currently, however, the system under investigation has not met the professional communications needs of a majority of its users. The differences between the experimental and control groups are not significant for most areas tested. Therefore, it cannot be expected that a BBS would serve as a an effective means of professional communication for any similar group of high school physics teachers.

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Appendix - A

Survey Instrument

Survey Cover Letter

My name is Donald McGarry. I'm currently working on a doctorate in Computer Education at Nova University in Fort Lauderdale, Florida. As part of my dissertation research, I'm trying to determine the effectiveness of bulletin boards as a means of communication among physics teachers.

You are listed as a registered user of the Physics Teacher Network bulletin board system in Winter Park, Florida. Mr. Howard, the system administrator, was kind enough to give me a list of system users so that I could contact you directly and ask that you answer some questions regarding your experiences with the system. Mr. Howard is also interested in your opinions and will receive a summary when I have compiled all responses.

As a favor to Mr. Howard and to me, please complete the enclosed questionnaire and return it to me in the return envelope provided. If you are interested in a summary of the results, please let me know and I will send you a copy when I have compiled all the data.

I realize that this is an inconvenience, but I ask that you cooperate so that the results are valid and meaningful. I thank you in advance for your time and cooperation.

Full Survey

PART I -- YOUR SCHOOL THIS YEAR

a. How many classes (sections) of physics are being taught? ____

b. Approximately how many students are enrolled in physics courses? ____

c. Approximately how many students are in the senior class? ____

d. How many years of science are required for graduation? ____

e. How many people (including yourself) are teaching physics? ____

PART II -- YOURSELF

a. For how many years have you been teaching high school physics? ____

b. How many physics classes (sections) do you currently teach? ____

c. Do you have a degree in physics? yes no

d. Did you teach physics when you began your teaching career? yes no

e. Have you taught physics for at least two-thirds of your career? yes no

f. Please give your affiliations with the organizations listed below by checking the appropriate line.

	none	inactive	somewhat active	very active
National Education Association (NEA)	____	____	____	____
National Science Teachers Association (NSTA)	____	____	____	____
American Association of Physics Teachers (AAPT)	____	____	____	____
National Council of Teachers of Mathematics (NCTM)	____	____	____	____
American Chemical Society (ACS)	____	____	____	____
American Federation of Teachers (AFT)	____	____	____	____
Other Professional Organizations (please list)	____	____	____	____

____

g. Check which (if any) of the following publications you read regularly?

__ Discover

__ Physics Today

__ Science

__ Science News

__ Science Digest

__ Scientific American

__ The Science Teacher

__ The Physics Teacher

h. What do you consider to be the main problems physics teachers face? (Check all that apply.)

__ Keeping up on physics

__ Keeping up on physics teaching

__ Student motivation, ability

__ Other (please list)

__ Student discipline

__ Lack of colleagues

__ Low pay

__ School administration

__ Lack of time

____

____

i. What sources of physics teaching ideas have you used or found helpful?_________________________________

____

j. What sources of information about ongoing developments in physics have you found helpful?

____

____

k. To what extent do you have contact with professional colleagues whom you talk to about physics or physics teaching?

	None	Some	Frequent	Desire more
Physics or other science teachers at your school	____	____	____	____
Physics or other science teachers at other schools	____	____	____	____
College/University faculty	____	____	____	____
Industrial or research scientists	____	____	____	____

PART III -- THE BULLETIN BOARD SYSTEM

a. What kinds of computer use were you familiar with before becoming a member of the system?

	personally familiar	taught children	taught adults
Modem use	____	____	____
uploading / downloading	____	____	____
Word processing	____	____	____
Logo or other programming	____	____	____
Computer as a measuring tool	____	____	____
Spreadsheets / databases	____	____	____
Other Educational software	____	____	____
Other (please list)	____	____	____

____

____

b. What do you have to do to get ready to log onto the system? ____

____

c. When you log onto the system, what do you usually do first? ____

____

d. Where is the modem phone line you use? home school

e. Is it easy to get to the phone line you use? yes no

f. Do you have to wait to use the phone line? yes no

g. Do you leave your computer and modem set up? yes no

h. Is it hard to find time to use the system? yes no

i. Did you incur any personal phone costs? yes no

j. Did phone costs affect you use of the system? yes no

k. Have you tried saving messages to disk? yes no

l. Have you tried uploading? yes no

m. Have you used the message editing features? yes no

n. Did you get involved in any extended discussions on the system? yes no

o. Which (if any) of the following problems did you have when getting started using the system?

__ Selecting / obtaining hardware

__ Telephone system

__ Selecting / obtaining software

__ Get busy signal often when calling

__ Using communications software

__ Using the system software

__ Other (please list)

____

____

p. Which (if any) of the following were helpful in getting started using the system?

__ Attended training session

__ Talked to other users

__ Called for (voice) help

__ Talked to computer people at school

__ The system manual

__ Posted questions on the system

__ Other (please list)

____

____

q. What suggestions do you have for improving user training? ____

____

r. Did you get to know anyone by interacting with them on the system, or by reading their messages? If so, did you develop any face-to-face contacts or activities with them? ____________________________

____

s. Did you get any teaching ideas, new physics information or update on materials on the system? If so, did you make use of these?

____

____

t. From your experience, how can bulletin board systems help physics teachers? What do you see as the best uses of this system for physics teachers?

____

____

u. What problems do you see with bulletin board systems and physics teachers? ____________________________

____

v. How has the system served or not served your interests as a physics teacher? (Please be as specific as possible.)

____

____

w. Any other suggestions or opinions about the system?

____

____

Question References

All questions on this survey were used either by Neuschatz and Covalt (1988) on the American Institute of Physics (AIP) national survey of physics teachers or by Katz, McSwiney, and Stroud (1987) during the Educational Technology Center (ETC) computer conferencing project interviews. Questions from the ETC project appeared on the Third Logon Phone Interview Script version 2/20/86.

The questions in Part I and Part II deal with the respondent and his or her school. All questions in Part I and questions 'a' through 'g' of Part II were used in the AIP survey. Answers were used to determine whether respondents' desire for increased professional communication varies among the three groups surveyed. Question 'h' in Part II was used by both the AIP and ETC projects. Wording varied somewhat but the choices were similar. The ETC questionnaire wording was used. Question 'k' of Part II is from the AIP survey because of its clear wording, but a similar set of questions was used in the ETC interview. The remainder of questions on Part II were used in the ETC interview.

Part III deals with the bulletin board. All questions are from the ETC interview with one change was made to question wording. References to science teaching were changed so that they refer to physics teaching. Questions in this part were used to determine the effectiveness of the BBS as a means of professional communication.

Appendix - B

Physics Teacher BBSs

Locating Bulletin Board Systems

Boardwatch Magazine, published by Jack Rickard, operates an electronic bulletin board system, the Boardwatch Magazine Online Information Service or BMOIS. BMOIS contains several lists of BBSs that are searchable. As of February 1994, the lists contained information about 44,000 operating in the U.S. The lists contained on BMOIS were used to conduct a search for additional physics teacher BBSs after this study was completed.

Each of the lists was searched using the keywords "education", "educational", "school", "teach", "teacher", "science", and "physics". After duplicate listings were removed, the number of BBSs meeting the search criteria was fifty-six. Of these, seventeen were operated by schools or school districts for student and public communication, eleven described themselves as being operated for teachers of all disciplines, sixteen were described as generally educational in nature, ten were listed as public BBSs catering to general science interests, and two were listed as physics BBSs. The physics systems are two of the three systems located earlier as candidates for this study. One is the target system that supplied the experimental group for the study. The other is the Massachusetts BBS described in Chapter III. The Massachusetts BBS has expanded its coverage of physics since 1989 when its system administrator was first contacted. Although it still emphasizes support for middle school and junior high science teachers, it also serves as a central location for discussion of physics topics. The physics section of the BBS, however, does not function as a support system for high school physics teachers. Instead, the physics discussion sections are open to the general public and discussions are mostly about topics in physics rather than physics teaching. These conclusions were made after several connections to the BBS during February 1994.

Biographical Sketch of Student

Donald L. McGarry was born in Huntington, New York in 1949 and attended public school in Northport, New York, graduating with honors in 1967. He attended the State University of New York at Stony Brook and received a B.S. degree in physics in 1971. At the same time he earned New York State teaching certificates in Physics, Earth Science, and General Science for grades 7 through 12 and began teaching in the Northport - East Northport Union Free School District. In 1972 he enrolled in the Continuing Education Department at the State University of New York at Stony Brook earning the degree of Master of Science in Applied Sciences in 1976. The same year he married Frances Beccaria. During his tenure at Northport, Mr. McGarry has taught general science, mechanical drawing, mathematics, compensatory mathematics, industrial arts, earth science general physics, and New York State regents physics. For two years he also served as advisor to the District Superintendent as a computer consultant. Mr. McGarry is working on the seamless integration of computer-based laboratories and computer data analysis into the high school physics curriculum and development of a laboratory curriculum for high school physics.

Nova University

Center for Computer and Information Science

This dissertation was submitted by Donald L. McGarry under the direction of the Chairperson of the Dissertation Committee listed below. It was submitted to the Center for Computer and Information Sciences and approved in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Computing Technology at NOVA University.

Approved:

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____
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