USE OF AEROSPACE ACTIVITIES IN THE CLASSROOM BY TEACHERS WHO HAVE ACCESS TO NASA SPACELINK

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Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF EDUCATION
December, 1996

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NASA SPACELINK

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PREFACE

This study was conducted to provide information that would assist in evaluating the effective use of Spacelink by educators. The study established the historical background for electronic educational resources, provided an overview of the resources available through Spacelink, surveyed a sample of teachers who have registered to use Spacelink as to their usage patterns and resultant teaching methods, and offered recommendations for the improved effectiveness of Spacelink as a teacher resource. This information will help NASA Spacelink meet the needs of the classroom teachers and meet the objectives of Spacelink, NASA, and aerospace education.

I would like to express my sincere appreciation to the following people:

My doctoral committee--Drs. Kenneth E. Wiggins (Chair), Cecil W. Dugger, Steven K. Marks, and John D. Vitek.

Oklahoma State University faculty and staff: Dr. Doris Grigsby, Iris McPherson, Kay Porter, Dr. Katye Perry, Stanley Jones, Debbie Brown, Dr. Lou Marshall, Wil Robertson, Marissa Delci, and Octavia Tripp.

My husband and best friend, Bill Taylor.

Spacelink personnel at the George C. Marshall Space Flight Center in Huntsville, Alabama: Jeff Ehmen, Alan Cunningham, Flint Wild, and Jeff Cobb.

My good friend and listener, Patsy Newman.

My editor and cheerleader, Carla Rosenberg.

And my mentor and coach, Dr. Eddie Anderson.

I also thank my parents, M. Joe and Aline H. Hardwick, who taught me the value of an excellent education and instilled in me the love of lifelong learning; and my children, Hanson R. and Maryellen Tipton, for continuing the tradition of educational excellence in another generation of our family.

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CHAPTER I

INTRODUCTION

Background

The National Aeronautics and Space Administration (NASA) Strategic Plan lists as the first of its three missions. "To advance and communicate scientific knowledge and understanding of the Earth, the solar system, and the universe, and use the environment of space for research" (1996, p. 1). One of the four strategic outcomes in the plan is "Educational Excellence. We involve the educational community in our endeavors to inspire American students, create learning opportunities, and enlighten inquisitive minds" (p. 1). The NASA Vision for Education is "to promote excellence in the American educational system through enhancing and expanding scientific and technological competence" (NASA Strategic Plan for Education, 1993, p. 1). The purpose of Spacelink (the NASA on-line database of educational resources) is to electronically disseminate text, graphics, and software to the fullest potential in order to maximize limited resources, and expand the delivery of programs to the broadest possible audience (Spacelink: On-line connection to NASA, 1995). The materials available on Spacelink support Goals 2000, the National Education Goals as outlined by President George Bush and the NASA Strategic Plan for Education.

NASA Spacelink is "an on-line computer database of educational resources administered by the NASA Headquarters Education Division" (Spacelink: On-line connection to NASA, 1995). Spacelink offers a wide range of materials (computer text files, software, and graphics) related to the space program. Its target audience is teachers, faculty, and students. The system may be accessed by computer through direct-dial modem at (205) 895-0028 or the Internet at this URL address: http://spacelink.msfc.nasa.gov.

The Spacelink materials are of interest to educators, and meet the Presidential Education Goals. Documents on the system include: science, mathematics, engineering and technology education lesson plans; historical information related to the space program; current status reports on NASA projects; news releases; information on NASA educational programs; NASA educational publications; and other materials chosen for their educational value and relevance to the space program. Materials on the system are organized and kept current by professional educators with experience in computer software applications and communications (NASA Spacelink Background, 1995). The database is arranged to provide easy access to current and historical information on NASA aeronautics and space research. Also included are suggested classroom activities that incorporate information on NASA projects to teach a number of scientific principles. These materials are available to the public through the Spacelink Public Electronic Library (SPEL).

In addition to the full range of space program information offered to all callers, Spacelink can provide several unique services designed especially for professional educators. Certified classroom teachers employed in a primary or secondary school

(public or private) in the United States or its territories may request authorization for these special features by contacting the Spacelink Administrator. The Spacelink Teacher Resource Center (STRC) is the component of the NASA Spacelink project in which special services are offered to professional educators. The STRC offers features available only with a registered Spacelink Educators Account. These services include: an E-mail account; on-line conferencing capabilities, for scheduled conferences with NASA scientists as well as private conferencing among teachers; bulletin boards; newsgroups; the Spacelink User Directory; and information about Internet services and providers. Bruning (1995) mentions that teachers are using Spacelink to share lesson plans and teaching strategies, and ask advice of experts (p. 49).

Technology-related objectives of the NASA Aerospace Education Services Program (AESP), for which Oklahoma State University is the contractor, are to utilize educational technology that integrates and models the NASA mission; to stimulate interest in science, mathematics, and technology content; and to support education reform (Aerospace Education Services Program Plan of Support, 1996).

> The AESP will provide teachers with instructional materials and strategies which reflect needs and demands of the 21st century. Specialists will model exemplary pedagogy and use high-quality instructional materials and educational technologies as they communicate fundamental aerospace-related scientific, mathematical, and technological information. Educational technology will be utilized to conserve resources, maximize the number of customers reached, and expand teacher and student experiences with technology (AESP Plan of Support, 1996, p. 3-4).

AESP Specialists train teachers to use Spacelink. They inform educators about the availability of Spacelink as a resource. They demonstrate and model its uses and capabilities, and assist teachers in finding the hardware, software, and local server necessary for access. They offer teachers the opportunity to access Spacelink by way of the toll-free number when commercial servers are not an option. AESP Specialists serve as the vital link between NASA and those members of the education community who are not yet aware of the potential uses of on-line resources. Without AESP, many educators may be unaware of the resource, uncomfortable trying to use it, or unable to access it.

Statement of the Problem

NASA Spacelink was first made available to the public in February, 1988. At that time the system ran on a Data MV7800 minicomputer. The system evolved rapidly, and by early 1993 it was apparent that a new system was needed to serve the growing numbers of educators and students who were beginning to utilize the high-speed communications and other features offered by the Internet. In response, NASA developed a second-generation Spacelink, which replaced the old system in September, 1994.

For those teachers who were still unable to access the Internet, NASA offered a limited number of toll-free accounts beginning January 13, 1995. As a result, Spacelink usage, and abuse of privileges, increased dramatically. More modems were necessary. The technical staff who monitor Spacelink had begun to notice certain usage patterns, and occurrences of abuse of privileges, since the inception of the toll-free accounts in January, 1995 (A. Cunningham, personal communication, March, 1995). Unlimited usage of time had to be cut back to one hour at a time. Concern has been expressed by the Aerospace

Education Specialists, who train teachers to use Spacelink, that because of limited access to hardware, software, and technical support, teachers may not be enjoying the full array of services offered by the on-line resource (Biggs, 1995).

Keeping in mind the original purpose and objectives of Spacelink and AESP, program administrators wish to determine whether those objectives are being met. NASA has devoted significant human and financial resources to create Spacelink. Because the NASA budget, in general, and NASA Education budget, in particular, are threatened by deep and continuing cutbacks, a need exists to quantify and qualitatively determine how effectively teachers are using Spacelink.

It is important to have ongoing assessment and evaluation to show the effectiveness and impact of Spacelink, to justify continued support from NASA. This study was designed to assess if educators use Spacelink effectively, to discover related problems and concerns, and to recommend modifications to enhance the quality of Spacelink in the future.

Purpose of the Study

This study provides information that will assist in evaluating the effective use of Spacelink by teachers. Information gathered will help determine:

- How teachers access their accounts (toll-free number, commercial server, or direct dial-up connection);
- How often and for how long teachers log on to Spacelink;
- Which Spacelink provided teachers use most often;

- Whether teachers download files, lesson plans, teacher guides, and software from Spacelink for use in their classrooms;
- What kind of hardware, software, and technical support is available in schools
- Whether students use Spacelink at school;
- Whether aerospace was part of the curriculum before the teachers had access to the NASA on-line resource;
- Whether access to Spacelink influences teachers' use of Aerospace activities in the classroom;
- Whether any correlation exists between Spacelink users and alumnae of various NASA Aerospace Education workshops;
- What is the highest level of education achieved by frequent Spacelink users.

Objectives of the Study

To accomplish this purpose, the following objectives must be met:

1. To establish the historical background for electronic educational resources;
2. To provide an overview of the resources available through Spacelink;
3. To survey a sample of teachers who have registered to use Spacelink with regard to their usage patterns and resultant teaching methods;
4. To offer recommendations to improve effectiveness of Spacelink as a teacher resource.

Definition of Terms

In this study, the following definitions will be used:

Aerospace Education. The use of aviation, space history, and science to inspire and motivate students to pursue studies in science, mathematics, engineering, and technology, thereby preparing them to function in the workplace of tomorrow.

Artificial Intelligence. The capability of a machine to imitate intelligent human behavior (Merriam-Webster's Collegiate Dictionary, 1994).

CD-ROM. Acronym for Compact Disk Read Only Memory, a disk that stores large amounts of textual and audiovisual information (Levine & Baroudi, 1993).

Cyberspace. General term used to refer to the electronic areas and communities existing on the Internet and other computer networks.

Distance Learning. Education coming from a distant source by way of telephone, television, computer system, or other technological means. Distance Learning technologies include: satellite delivery systems, open broadcasts, cable, fiber optics, microcomputers, digital compression, interactive videodisks, facsimile machines, and the ordinary telephone.

Educational Technology. The use of technologies such as computers, phone lines, modems, communications satellites, cellular services, wireless transmitters, cable television (TV) and other providers of electronically transmitted information to enhance the quality of education.

Effectiveness of dissemination. A quantitative description of the coordinated effort to use Spacelink as an enabling system in meeting the goals of the NASA Strategic Plan

for Education, which calls for ensuring "that we maximize our limited resources and expand the delivery of programs and materials to the broadest possible audience through the appropriate use of educational technologies" (p.1). The plan further states the goal of implementing new education reform initiatives which specifically address national education reform, including educational technology.

E-mail. Messages delivered electronically by way of computers connected by modems to telephone lines or to the Internet.

Gopher, Archie, Veronica. Internet search tools, capable of searching database after database looking for files that match a given description (Levine & Baroudi, 1993).

Hardware. The actual computer and related machines.

Host. The Internet address of the computer system on which the server is running.

Internet. A network which has evolved from a U.S. Department of Defense communications system to become an interconnected collection of more than 46,000 independent networks, public and private, around the world. Now serving millions of users worldwide, its growth is rapid and exponential (Bruning, 1995, p.49).

Modem. Short for "modulate-demodulate;" a device which allows computers to communicate over telephone lines or other delivery systems (Levine & Baroudi, 1993).

Newsgroups. Lists of subscribers who receive E-mail messages related to certain selected topics.

On-line. Connected to, served by, or made available through a computer or telecommunications system (Levine & Baroudi, 1993).

Path and Filename. Part of an Internet address which identifies the directory section and file of interest. The path describes the process followed to locate the address.

For example, the path for the NASA Microgravity Teacher Guide is: http://spacelink.msfc.nasa.gov/Instructional Materials/Curriculum Materials/Sciences/Microgravity/Microgravity.Teachers.Guide.6-12/The words between the final two "slashes" (Microgravity.Teachers.Guide.6-12) are the filename.

The publication "Microgravity Teacher Guide" is located four levels, or directories within the Spacelink website. The first level is "Instructional Materials". Under "Instructional Materials", choose "Curriculum Materials" to find the heading "Sciences," and within the "Sciences" section select the "Microgravity" folder, where the teacher guide resides (Rosenberg, 1996).

PINE™. The University of Washington's Program for Internet News and E-mail, intended to be an easy-to-use program for sending, receiving, and filing Internet electronic mail messages and Usenet news messages. Pine supports the following Internet protocols and specifications: SMTP, MMTP, MIME, and IMAP. Spacelink uses PINE[a] because it is reliable, easy to use, and free. The Spacelink administrator was able to download it from the University and configure it to work on the Spacelink system with very few changes necessary (Wild, 1996).

Server. A powerful computer on a network that provides a particular service and information to other computers; for example, a print server manages a printer.

Software. A computer program; loosely defined, a package of instructions to be used on your hardware (Merriam-Webster's Collegiate Dictionary, 1994).

Spacelink. An on-line database of resources established by NASA for the purpose of electronically disseminating information relating to aeronautics and space to the broadest possible audience (Spacelink: On-line connection to NASA, 1995).

Spacelink Educator Account. Limited text-only Internet account designed to introduce educators to the vast resources that NASA offers via the Internet. It provides an E-mail address, access to special newsgroups, and access to on-line conferencing for those educators who might not otherwise have access to the Internet (Wild, 1996).

Spacelink Public Electronic Library. The on-line service which provides access to the publicly available materials on Spacelink.

Spacelink Teacher Resource Center. A service available only to educators who have Spacelink Educator Accounts. It provides access to: the Spacelink Library of information, a search feature for the library of documents, NASA Internet resources, an E-mail address/account, Spacelink and selected Usenet newsgroups, on-line conferencing, and additional Internet resources (Wild, 1996).

World Wide Web. Network based on "hypermedia" that handles graphics, sound and text (Bruning, 1995, p. 49).

Virtual Reality. Computer-generated visuals simulating a real or imaginary environment (Merriam-Webster's Collegiate Dictionary, 1994).

Abbreviations and Acronyms

ATM	Asynchronous Transfer Mode
CAI	Computer Aided Instruction
CCSSO	Council of Chief State School Officers
CD-ROM	Compact Disc-Read Only Memory
ESEA	Elementary and Secondary Education Act
FTP	File Transfer Protocol

GIF	Graphical Interchange Format
HPCC	High Performance Computing and Communications
html	Hyper Text Markup Language
http	Hyper Text Transfer Protocol
IDEA	Individuals with Disabilities Education Act
IITA	Information Infrastructure Technology and Applications
IMAP	Internet Message Access Protocol
MIME	Multipurpose Internet Mail Extensions
MSFC	NASA George C. Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NESIC	National Education Standards and Improvement Council
NII	National Information Infrastructure
NNTP	Network News Transport Protocol
NTIA	National Telecommunications and Information Administration
PPP	Point to Point Protocol
SLIP	Serial Line Internet Protocol
SMTP	Simple Mail Transport Protocol
STRC	Spacelink Teacher Resource Center
URL	Uniform Resource Location
USE IT	United States Education and Instruction through Telecommunications
WAIS	Wide Area Information Servers
WWW	World Wide Web

Assumptions

For the purpose of this study, the following assumptions have been applied:

1. Using aerospace activities in the classroom is desirable and promotes interest in science, mathematics, and technology.

2. Educators who register for a Spacelink Educators Account log on to Spacelink again after they register.

3. Educators who log on to Spacelink use it for information retrieval, not just to communicate by way of E-mail.

4. Effective use of Spacelink means meeting the goals and objectives of Spacelink, the NASA Strategic Plan, and the NASA Strategic Plan for Education.

Limitations of the Study

The study was limited to educators who have registered for Spacelink Educator Accounts and the sample of registered educators who have logged on to Spacelink for twenty-five hours or more. The study did not include measures of attitudinal change resulting from use of NASA Spacelink or training to use Spacelink. Because of the descriptive nature of the study, it did not gauge the quality and quantity of the teachers' use of aerospace activities in the classroom. Future research will be needed to describe this element.

This study did not examine the relationship of the use of Spacelink to the demographics of the users, including geographics, socio-economics, grade levels, and years of teaching experience. It did not address the influence of teacher exposure to other

sources of resources and support in aerospace education including: Challenger Centers, Young Astronauts, U.S. Space Foundation, Civil Air Patrol, Space Camp, Astronaut Memorial Foundation, Science Museums, Observatories, Planetariums, and local aerospace-related businesses and industries.

Significance of the Study

This study is the first effort to systematically examine and describe the usage patterns of NASA Spacelink. Information provided by this study will be used to determine what improvements and changes should be made in this on-line teacher resource to make it more "user-friendly" and accessible to every teacher in the United States.

Organization of the Study

This descriptive research was designed to provide information to assist in evaluating how effectively educators use Spacelink. Information was gathered with a survey distributed on-line by electronic mail to a sample of educators registered to use Spacelink Educators Accounts, who had logged on to Spacelink for twenty-five hours or more as of January, 1996. Follow-up data was collected by telephone, facsimile, and mail. The study is specific to NASA Spacelink and its users, and therefore, its results can be assessed only to the population of educators who have registered for Spacelink Educator Accounts. These accounts are available, free of cost, to any educator in the United States.

Following this introductory chapter, Chapter II reviews related literature in educational technology and distance learning, including: an overview of the resources available on Spacelink; a historical background of electronic educational resources; the

role of technology related to Educational Reform in the classroom and in educational professional development; and policies to support the use of technology in education. Chapter III discusses the procedures used to collect the data and analyze it in detail. Attention is given to the population, the selection process, and size of sample. The development, validation, and scoring procedure of the instrument used to measure Spacelink usage will be described. Chapter IV explains the statistical treatments employed to analyze the data and applies the results of these analyses to the research questions. Chapter V summarizes the major findings and conclusions, and recommends topics for further study (See Appendix F).

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

This chapter includes a review of selected sources of information that give an overview of the resources available through NASA Spacelink (hereafter referred to as Spacelink), the historical background of electronic educational resources, the use of technology to support Education Reform, policies to support the use of technology in education, and the rationale and the reality of using educational technology.

Spacelink

Spacelink is "an on-line computer database of educational resources administered by the NASA Headquarters Education Division" (Spacelink: On-line connection to NASA, 1995). The host computer is located at the NASA Marshall Space Flight Center (MSFC) in Huntsville, Alabama. Information on NASA scientific projects and educational programs is provided to Spacelink by education specialists at NASA Headquarters and the NASA Field Centers. Materials on the system are organized and kept current by professional educators with experience in computer software applications and communications (NASA Spacelink Background, 1995). Users may access the system by

computer through direct-dial modem (205) 895-0028 or through the Internet using the URL "http://spacelink.msfc.nasa.gov"(See Appendix D).

Spacelink offers a wide range of materials, including computer text files, software, and graphics related to the aeronautics and space program. The target audience of this service is teachers, faculty, students and Internet users. The system is intended to help facilitate Goals 2000, the National Education Goals as outlined by President Bush and the NASA Strategic Plan for Education. Documents available to all users on the system include: science, mathematics, engineering and technology education lesson plans; historical information related to the aeronautics and space program; current status reports on NASA projects; news releases; information on NASA educational programs; NASA educational publications; and other materials chosen for educational value and relevance to the aeronautics and space program.

Spacelink was first made available to the public in February, 1988. By early 1993 it became clear that a new system was needed to serve the growing numbers of educators and students who were beginning to utilize the high-speed communications and other enhanced features offered by the Internet. In response to the heavy volume of calls, NASA developed a second-generation Spacelink, which replaced the old system in September 1994. Major funding for the program has been provided by the Education Division at NASA Headquarters.

The system is specifically designed for educators. The database is arranged to provide easy access to current and historical information on NASA aeronautics and space research. Also included are suggested classroom activities that incorporate information on NASA projects to teach a number of scientific principles. Bruning (1995) mentions that

teachers are using Spacelink to share lesson plans and teaching strategies, and ask advice of experts (p.49).

In addition to the full range of information on the space program offered to all callers, Spacelink can provide several special services designed for professional educators. Certified classroom teachers employed in a primary or secondary school (public or private) in the United States or its territories may request authorization to access these special features by contacting the Spacelink Administrator by voice phone (205) 961-1225, E-mail "comments@spacelink.msfc.nasa.gov," the Internet World Wide Web "http://spacelink.msfc.nasa.gov," or mail c/o Spacelink Administrator, Education Programs Office, NASA Marshall Space Flight Center, Huntsville, AL 35812-0001. The Spacelink Teacher Resource Center (STRC) is the component of the NASA Spacelink project which offers special services to professional educators (See Appendix D). The STRC offers features available only with a registered Spacelink Educators Account. Services provided by the STRC include:

- Spacelink Public Electronic Library - This service provides access to the NASA Spacelink materials that are available to the public. It is not a part of the STRC, however teachers have the same access as any other user. Subject areas include: About Spacelink, Educational Services, Instructional Materials, NASA News, NASA Overview, NASA Projects, Spacelink Frequently Asked Questions, and Spacelink Hot Topics (Spacelink, 1995).
- Other on-line resources on the Internet - A Spacelink educator account provides a gateway from Spacelink to a wealth of information on the Internet. Spacelink has a search feature to find topics of interest available

on Spacelink, and has links to related topics on the Web. Various tools may be used to search the Internet for specific information, visit any of the numerous Internet sites listed on Spacelink, or go to virtually any Internet site of choice. The STRC provides access to Telnet, FTP, Gopher, and World-Wide-Web sites.

- Electronic Mail - Registered STRC users have their own "E-mail" accounts which allow them to exchange messages with any other E-mail users.
- Usenet Newsgroups - A Spacelink E-mail account allows authorized teachers to participate in Usenet News, a world wide electronic discussion forum. New users are automatically given a subscription to a selection of newsgroups likely to be of interest to teachers who use Spacelink. They have full capability to post Usenet News articles, reply to articles, or simply review current discussions.
- Spacelink On-line Conferences - Live moderated keyboard conferences are scheduled periodically in which educators may ask questions of guest speakers, such as NASA scientists. Teachers can also set up their own conferences to discuss topics of choice with other Spacelink educators.

(See Appendix D to view the Spacelink Internet home page.)

Teachers with STRC accounts may "leave" NASA Spacelink via a gateway that allows free and open access to Internet sites around the world. Typically these sites are established by commercial business, government and educational institutions who want to make information available to the public and promote the exchange of ideas. Teachers should be aware that the Internet may contain, among its many educational treasures,

certain materials that they, their students, and their students' parents might consider offensive. If teachers choose to allow K-12 students to have access to this gateway under their names, they should supervise the students' activities closely.

Usenet news is the electronic discussion forum of the Internet. Usenet news contains hundreds of "discussion areas" or "newsgroups" where people meet to exchange ideas on specific topics. Discussions take place in a series of messages from callers. One person will post a question or comment, and within hours or days, others will respond by a public posting for all to read or by private E-mail to the original poster. Messages posted to newsgroups often bring quick replies from experts on the subject.

Spacelink does not provide access to all Usenet newsgroups. The newsgroups that have been selected to appear on Spacelink have been chosen for their educational value. Access has been blocked to newsgroups which contain discussions many would consider offensive, but Usenet newsgroups may contain strong language and adult discussions. Again careful supervision of minors is recommended.

The Spacelink Teacher Resource Center's on-line conference feature allows multiple users to chat with each other while they are on-line. Periodically Spacelink schedules live discussions with NASA experts on specified educational topics. Even during a scheduled event educators may conduct their own public and private discussions because Spacelink supports multiple sessions.

Spacelink's conference feature is like a large convention center. It consists of a lobby into which everyone enters and numerous meeting rooms into which groups of people can go to discuss various topics. When teachers select "Spacelink On-line Conferences," they automatically enter the conference center's lobby area, which is called

"newuser" [sic]. From here they can issue commands to see who is in the conference center, read about topics being discussed by current groups, and join a discussion group, or create their own discussion session.

The conference system can support multiple conference sessions at the same time, each identified by a conference name. Conferences can be moderated or unmoderated. Both types of conferences facilitate live text conversations between the participants. Moderated conferences are hosted by speakers and allow for other participants to ask questions. The speakers may select questions to answer and post the questions and answers for all to see. When Spacelink hosts a conference with a guest speaker such as a NASA scientist, this is the format used. Unmoderated conferences allow for all participants to discuss a topic. All discussion is seen by everyone joined in the session. However, a user may hold a background discussion by sending a message directly to another participant without displaying it to the group.

NASA Spacelink is a dynamic system. It grows and changes daily, as new resources become available and new technology is developed, because policy makers are becoming aware of the tremendous potential of educational technology as a resource to students and teachers. It is recognized as a vehicle for professional development, and as a requirement for preparing future generations for their place in a highly technical workplace. As more and more educators are supplied with computers, modems, and phone lines in their classrooms, they are providing feedback which prompts changes and improvements in the services and offerings of Spacelink. In the years to come NASA is committed to using Spacelink to increase students' and teachers' knowledge about space

and aeronautics as well as helping teachers use Spacelink to expand their abilities to use technology more effectively.

Historical Background of Electronic Educational Resources

Technology is defined as "a body of knowledge and the systematic application of resources to produce outcomes in response to human needs and wants" (Savage & Sterry, 1995, p. 7). It only follows that technology and education join together naturally. Withrow and Kohls (1995) said, "Ever since the first correspondence courses provided schooling to pioneers settling the untamed West, distance learning has been a part of American education" (p. 22). By 1900 radio broadcasts of "School of the Air" provided formal educational programs to listeners in homes throughout the country. In the 1950's the first televised courses for college credit were offered, and by the late 1980's, 20-year-old satellite technology had become a popular and cost-effective way to deliver instructional programming. "Today, quantum leaps in communications and information technology have dramatically changed the context of distance learning. What was once seen as merely an alternative method for delivering instruction is now a powerful resource for high-quality, lifelong learning" (Withrow & Kohls, 1995, p. 22).

"Distance learning transports information, not people" (U.S. Congress report from OTA, 1989, p.3). What makes distance learning efforts today different from those in the past is the improvement of the interactive capacity made possible by new technology (p. 4). With the advent of interactive learning, the role of the teacher has become subject to debate. Some see future teachers as facilitators guiding the use of technology. As a

result, the importance of professional development increases as new technologies emerge.

Teachers may be called upon to broadcast their lessons to distant audiences. They need to acquire techniques for effectively presenting activities and materials before a camera as well as to a live audience. Teachers must be prepared to understand and operate the new equipment for interactive participation. They may find themselves supervising a class whose main instruction comes from a distance via satellite, supplementing the lecture with group projects, discussions, and hands-on activities. Staying up-to-date with changes in technology will be an on-going challenge.

Zorfass (1995) stressed the potential of on-line education in improving professional development. Teaching with hands-on practice with the tools is important. Computers are useful in teaching visually impaired students and others with special needs. Families can become involved in technology education as increasing numbers of homes are equipped with computers, modems and software, and parents are trained to use computers in their jobs.

The array of distance learning resources includes broadcast television, satellite, cable, microwave, computer, and telephone networks, as well as innovative new applications, such as direct broadcast satellites (DBS), digital compression, and inexpensive, user-friendly communications software. Old and new technologies are being combined and integrated in ways that not only fill gaps in curriculum or training objectives, but also offer better learning opportunities. "Today, electronic educational resources such as digital video, fax machines, electronic mail, instructional software, and traditional classroom activities coexist in an enriched learning environment" (Withrow & Kohls, 1995, p. 22).

"The telecommunications industry is rapidly developing the growing web of complementary and competitive services commonly referred to as the National Information Infrastructure, or NII. The NII promises to provide full voice, video, and data services, presenting an unprecedented opportunity to offer quality education to more citizens than ever before" (Withrow & Kohls, 1995, p. 22).

By far the largest computer network in the world is the Internet, a network of networks that share a common set of protocols. It provides access to databases and networks around the world (U.S. Congress report from OTA, 1995). According to Gauger (1994), the Internet evolved from a U.S. Defense Department communications system to become an interconnected collection of more than 46,000 independent networks, public and private. Now serving millions of users worldwide, its growth is rapid and exponential (p. 47). Teachers who use the Internet mention the ways it can "extend the learning environment" for students (U.S. Congress report from OTA, 1995, p. 110). It offers potential for equality in education by allowing students to communicate with other students electronically instead of face to face. This minimizes the distractions of social status, race, or cultural differences.

Students and teachers are using computers for: E-mail, which includes distribution lists, newsgroups and electronic bulletin boards; file transfers (FTPs), which allow users to copy files containing text, software, pictures, and music; and Telnet, which allows users to log onto a remote computer as if it were in the same room. The tools used to browse through the files on the Internet include Gopher, Archie, Veronica, Mosaic and Netscape. Students may use computers to send their work to some other parties for evaluation or response. They communicate with pen pals, scientists, and experts on various subjects.

The Internet serves as a forum to learn about distant events and different cultures. The exchange of writing samples with professional writers for editing and engineers for technical review provides a valuable dialogue. Information technology in the classroom does much more than boost enthusiasm or expand information sources. Its use fundamentally alters the roles of teachers and students (Peha, 1995).

The Internet changes how students may learn in the classroom. Internet access makes it possible for students to collaborate on group projects with group members at different schools. They engage in meaningful exploratory science with a large body of data. Students explore remote data sources and processing capabilities on the network. Computationally intensive scientific simulations can be run on a powerful remote computer. These simulations can replace expensive or dangerous laboratory equipment in the school. Students become aware that they are part of the global community. Technology gives students a wide variety of resources, stimulates thinking, and improves computer literacy.

Perhaps more importantly, the Internet is being used as a tool for curriculum enhancement and professional development by teachers. Patterson (1995) stated his belief that no lasting positive change would occur in education unless quality professional development opportunities were provided. "Educators must be, and want to be, learners" (Patterson, 1995, p. 2). With dwindling funding for campus-based professional growth activities, new technology provides feasible and more affordable opportunities for distance learning.

Many states are beginning to provide models for state and local planning for technology education. One such plan, from Virginia (1992), defines technology and

technology education, states mission and goals, specifies objectives for technology education in early childhood, pre- and early adolescent, and high school education, and suggests program criteria (p. 27). Ideas for implementation include: (a) a strong linkage with mathematics, science, society, and the environment; (b) experiential activity-based learning emphasizing the "holistic" quality of education; and (c) making technology an essential partner with math and science in contemporary education (p. 28). Local and state politics will affect the teachers' workload as classrooms become connected to the Internet and teachers are trained to integrate technology education into the curriculum. Distance learning has been around since the 1900s using the mail system for correspondence courses and later the radio to engage students using technologies that were mostly one-way information dumps. As technology has improved and diversified using cable television, computers, phones, faxes, and video conferences, not only has the scale of distance learning increased, so has the amount of interaction between teacher and students. Technology increases the quantity, quality, and timeliness of information available to teachers and students, expanding the learning community beyond the classroom to world-wide proportions. It can break down cultural barriers and allow students to engage in authentic learning experiences like those they will encounter in the working world. If technology facilitates these types of interactions, it follows that teachers' roles in the classroom have to expand to encompass different methodologies and their skills must increase in using new technologies. In fact policies supporting education reform using technology are becoming increasingly more prominent.

The Use of Technology to Support Education Reform

In 1994 the 103rd Congress passed significant education legislation, including the Goals 2000 Educate America Act, specifying comprehensive national objectives for education in this country. This legislation, for the first time, provided leadership and funding support to plan educational technology. "Schools, colleges, and businesses are all realizing the potential for distance learning resources to provide greater access to effective educational experiences. Clearly, distance learning is a growing piece of the mosaic of learning technologies needed to achieve the nation's education goals" (Withrow & Kohls, 1995, p. 23). Schools are acquiring more and more computers, software, and Internet connectivity. Innovative computer-assisted learning systems, including management components, are proving to be more than just programmed learning. Improved electronic communications and two-way video are facilitating the implementation of inquiry-based constructivist education methods.

Sheingold (1995) sees a potential for synergy in restructuring for learning with technology. "It is not the features of the technology alone, but rather the ways that these capacities are put to use in human environments that shape their impact" (p. 9).

One of the early uses of computers in schools was in the Integrated Learning Systems (ILS) (Wiburg, 1995, p. 7). These were integrated hardware/software systems that delivered courseware generally related to basic skills learning. They included management components that collected and recorded results of student performance. These systems were controversial in that they were widely viewed as nothing more than programmed learning.

New technologies have begun to offer more than just distributed courses. Electronic communications and high-quality two-way video programming have made electronic field trips possible, as well as access to remote sites and distant experts, and unique opportunities for dialogue and collaboration. "Increasingly, distance learning is doing more than just bringing the class to the learner; it is truly breaking down classroom walls" (Withrow & Kohls, 1995, p. 23).

Telecommunications networks are linking homes, libraries, schools, and businesses into a community-wide learning resource. They are changing the very nature of teaching. Planning for the use of these technologies requires a rethinking of traditional education structures, from administrative organization and cost accounting systems to teacher training and instructional design. Effective use of distance learning depends on a combination of expertise in technology, content, infrastructure building, and school administration. Few institutions offer opportunities to bring this expertise together. A major barrier to planning is the lack of "technology-friendly" organizational environments. Federal, state, and local governments, educators at all levels, private industry, and telecommunications service providers must work together toward making distance learning affordable, effective, and accessible (Withrow & Kohls, 1995).

A report was presented by the United States Education and Instruction through Telecommunications, or USE IT, project for the Council of Chief State School Officers (CCSSO). This project was completed on behalf of the U.S. Department of Commerce, under cooperative agreement with the National Telecommunications and Information Administration (NTIA). The report makes recommendations for ensuring the effective use of telecommunications technologies for lifelong learning. These include:

- Supporting the development and use of distance-learning resources to achieve the National Education Goals;
- Striving to achieve equitable access to distance-learning resources;
- Supporting and developing distance-learning delivery systems and information networks that are compatible and interoperable;
- Exploring methods for the cooperative, cost-effective use of distance learning facilities and services;
- Promoting public/private partnerships by governments, together with local communities, educational institutions, and the telecommunications industry for distance learning, and supporting regional and statewide applications of distance learning to form an integrated national resource;
- Developing policies by regulatory agencies that ensure affordable rates for the educational uses of telecommunications resources;
- Ensuring availability of universal telecommunications services for all levels of lifelong learning;
- Maintaining reasonable fair-use copyright guidelines for instructional materials used in distance learning;
- Developing new resources for investment and capital development for distance learning, and coordinating to provide efficient and effective funding uses;
- Incorporating the uses of distance learning programs as educational resources and providing the technical training required to use such resources in professional development programs for educators and administrators;

- Improving course accreditation procedures to advance the use of distance learning and other alternative education offerings;
- Developing cost-accounting standards that provide accurate information on unit-of-instruction costs and instructional effectiveness assessments for distance learning;
- Creating organizational environments conducive to planning for learning technologies;
- Joining forces of professional development programs for educators and administrators to strengthen distance-learning content requirements for instructional formats;
- Undertaking awareness and outreach activities to inform educators, business and industry, and the public of the value and importance of distance learning to achieve the National Education Goals (Withrow & Kohls, 1995, p. 25).

Journals of the National Science Teachers Association and National Council of Teachers of Mathematics now have regular monthly features on educational technology. Reviews of new materials include software and computer resources. In the feature column "Tech Trek" in NSTA's *Science Scope*, examples were given of ways to use technology to align classroom activities with the National Science Education Standards.

> This past year . . . I used technology with my students in several ways: we did a 'Show and Tell' using the Internet; we created a computer simulation lab on seed germination using SimLife; we wrote a story about space travel after viewing a Quicktime movie downloaded from NASA's Spacelink; we viewed a paramecium's contractile vacuole using a video camera for the microscope; we used a spreadsheet to analyze data and make graphs after water testing our local

> creek; we rescued satellite probes lost in the solar system using a laserdisk program; we wrote and edited a lab report using Claris Works; and much more (O'Neil, 1995, p. 16-18).

These activities illustrate the versatility of educational technology and exemplify the variety of methods available for integrating the curriculum and accommodating the many learning and teaching styles present in today's classroom. They illustrate ways in which educational technology facilitates the implementation of recommended standards-based systemic reform.

Alden and Curyea (1994) defined the Information Highway as "the interconnection of thousands of computers through phone and cable lines that enables us to send and receive vast volumes of information at phenomenal speeds throughout the world" (p. 4). They see the information highway today as a primitive precursor, "a system of back roads - or at best, state roads -" (p. 4) in relation to the Information Superhighway that tomorrow will bring. They lament that most of our classrooms are not yet connected to the Information Highway because they do not even have the basic equipment required: a computer, a modem, communications software, and a phone line. Alden and Curyea suggest steps to increase children's access to the Information Highway. These include: (a) recognizing that connection should be a priority; (b) "getting the computers out of a lab and into the classrooms, where real learning takes place" (p. 5); (c) connecting to the Internet either directly or through a commercial server; and (d) providing support and training for teachers, including time to practice (p. 5).

The new range of opportunities to improve (and reform) education stem from the richness of capabilities available through distance learning technologies. Student and

teacher knowledge expands outside of the classroom to encompass the world through links to libraries, agencies, businesses, and people around the world. Virtual field trips are possible, as well as alternate ways of assessing student performance. The type of learning experiences available through connectivity can indeed lead to education reform.

Professional teaching journals devote sections to the use of technology in the classroom. Presidential policy (Goals 2000) calls for technology to play a role in education reform and to promote lifelong learning. Policies on the national, state, and local levels support the use of new technologies in Education.

Policies to Support the Use of Technology in Education

The Goals 2000: Educate America Act (Public Law [P.L.] 103-277) called for the creation of an Office of Educational Technology (OET) within the Department of Education. The need for high-level coordination of technology issues had already been recognized by the Secretary of Education in the appointment of a Director of Educational Technology in 1993 (U.S. Congress report from OTA, 1995). It is the responsibility of this office to provide a spotlight on technology, coordinate programs, and lead in evaluating and disseminating research results. The OET should make the most of the national long-range technology plan to be developed by the Secretary of Education in accordance with Goals 2000. All national agencies and programs should be used wisely to expand, evaluate, and build upon knowledge in educational technology to affect teacher preparation and professional development of the current teacher force. Goals 2000 contains other provisions that could set the direction for educational reform for the next several years and could be used to leverage improved technology policy. A key provision

authorized federal grants to states that developed a systematic state-wide plan to increase the use of technology that enhanced elementary and secondary student learning and staff development (P.L. 103-277, 20 USC 5897).

Also under Goals 2000, states may submit applications to receive funds to establish state content and performance standards for student learning. The inclusion of technology issues in these standards signals that technology is an appropriate tool for all core subjects. The law established a National Education Standards and Improvement Council (NESIC) to review and certify the standards.

The Improving America's Schools Act (P.L. 103-382), with its amendments to the Elementary and Secondary Education Act (ESEA) of 1965, included a major new Technology for Education Act which provides a stronger federal role in providing technology-related professional development for teachers. The revised Eisenhower Professional Development program, given greater emphasis in P.L. 103-382, calls for a larger federal teacher professional development effort, which should include the integration of technology.

Ramiriz and Bell (1994) made the following recommendations in relation to government policy on the use of technology in education:

- Federal level - enact legislation which includes a clear focus on ways to provide resources for development and technology implementation, with provisions for planning grants and grants for hardware acquisition. Connect investment in educational technology to state plans for content standards, based on the standards being developed in the content areas by national professional organizations.

- State level - enact legislation that supports the federal position and provides resources in the areas of technical support, professional development, planning and leadership. Develop and implement state regulations that provide schools with universal and affordable access to telecommunications and information technologies.
- Local level - use professional development resources available from the state to support students in their use of inquiry-based learning strategies, tap local expertise, and use telecommunications and information technologies to access national and state databases with the curriculum (p. 4).

Hanley and Zantal-Wiener (1995) pointed out that educational technology has become an important tool for delivering instruction to children with special needs. They refer to new technologies as "cognitive prostheses" (p. 4). Some of the technologies developed for individuals with disabilities, such as the Optical Character Reader (OCR), speech synthesis systems, and closed captioning, are becoming functional tools for all learners.

Title I of ESEA for disadvantaged children (Chapter 1), Individuals with Disabilities Education Act (IDEA), and the Bilingual Education Act, channel almost $10 billion to states and school districts. P.L. 103-382 states that currently "insufficient attention and resources are directed toward the effective use of technology in schools and the role technology can play in professional development and improved teaching and learning" (U.S. Congress report from OTA, 1995).

The Stevenson-Wydler Technology Innovation Act of 1980 (P.L. 96-480, 94 Stat. 2311, USC 3704) directed that government agencies make their excess equipment

available to small businesses and educational institutions. Schools which need hardware should explore this source of equipment (Creating a Government, September, 1993).

The Star Schools Program, initiated by Congress in 1988, was a bold move to fully legitimize the role of technology to enhance instruction, increase teacher productivity, create new teaching and learning communities, and support educational change. The primary purpose of Star Schools is to use technology to meet educational needs. With FY 95 funding of $30 million, the goal is to improve instruction through grants to telecommunications partnerships for programming and facilities. The funds may be used to develop and provide preservice and inservice distance learning for teachers and to train them to integrate telecourses for students into instruction. This effort is being emphasized after criticism early in the program that many of the distance-learning staff development activities "imparted information to teachers as passive recipients--in other words, old delivery in a new package" (Distance Learning Primer, 1995).

Through Star Schools, students in rural and inner city schools can study Chinese or advanced placement physics when a local teacher is unavailable. The projects use satellites, fiber optics, cable, microcomputers, digital compression, interactive videodiscs, facsimile machines, telephone, and the Internet. "Teachers and other educational personnel can participate in teleconferences and communicate with colleagues in other places through staff development programs and formal inservice courses designed to meet local needs" (Star Schools Program, 1995, p.12). Parents can also take advantage of opportunities available through the Star Schools projects. All lessons follow national standards and support Goals 2000.

In an introductory letter for a report from the National Institute of Standards and Technology, Brown (1994) introduced the National Information Infrastructure (NII), which was established to oversee the facilities and services that enable efficient creation and diffusion of useful information in the United States (p. I). The report describes the vision for the use of the NII in education and lifelong learning, the educational benefits of technology, and issues and goals in future development (p. 68). Some of the issues facing the NII include: pending legislation, cultural and language barriers, monopolies in telephone and cable distribution, funding sources, security for intellectual property rights, information retrieval tools to locate and select resources, and equality of access (Stout, 1995).

President Clinton announced in his State of the Union Address (1994), "We must set tough world-class academic and occupational standards for all our children and give our teachers and students the tools they need to meet them." Toward that end, the Foundation for Industrial Modernization (1995) has developed voluntary, industry-based National Occupational Skills Standards for Computer Aided Drafting and Design (CADD) "to assist educators and trainers in the development of their curriculum and . . . ensure that students and workers develop the skills necessary for employment" (p. 10). These standards, like those emerging in the disciplines of mathematics, science, and others, form the framework for systemic reform in education. They are closely related to the development of educational technology and the "information infrastructure."

Presidential policies have led to the development of additional offices in the Department of Education and other national agencies to legislate support for the development of federal, state, and local policies for educational reform and the use of

technology. The results have included grants to help build a national information infrastructure for all schools, the development of curriculum standards by professional education organizations, and technical support to teachers, the expansion to broaden reaches of distance learning and focus on rural, intercity, minorities, and the learning disabled. Legislation does not immediately lead to the attainment of Presidential goals. The reality and the rational behind technology have to overcome obstacles.

The International Technology Education Association is currently in the process of developing standards based on the rationale and structure for technology education in grades K through 12. Their report on Technology Literacy (1995) states that there are few articulated technology studies programs for K - 12 students in this country because of:

- Lack of consensus on what should comprise technology programs;
- Confusion concerning the relationship of a technology program with other allied disciplines, such as science, mathematics, the humanities, and art;
- Inadequate resources within school systems to conceive and develop such a program;
- Insufficient numbers of teachers prepared to teach technology (International Technology Education Association, 1995).

To help assure every classroom has access to the basic Internet, the Clinton administration formally recommended in October, 1996 that a federal-state Federal Communications Commission board give all schools free Internet access and discounted rates for special services. The 1966 Telecommunications Act guarantees discounted rates, and the regulatory panel met in November, 1996 to set them (Page, 1996).

The Rationale and the Reality of Using Educational Technology

In commenting on a new report from the Office of Technology Assessment (Teachers and Technology, 1995), O'Neil still saw an enormous gap between the fantasy of technology enthusiasts and reality. He described the biggest barriers as being: (a) under equipped schools; (b) computers still trapped in computer labs; (c) inadequate training for teachers; (d) preservice programs that do not prepare graduates to use technology as teaching tools; (e) "overall lack of vision and clarity of goals with regard to technology's role in the school" (p. 11); and (f) overemphasis on "getting the technology" (p. 11) with underemphasis on how to change instruction. The biggest barrier, as O'Neil saw it, was time; time for training, time for trying out and talking about the technology with other teachers. "If teachers aren't given more time to explore the uses of various technologies, and if the help they need in terms of training and support isn't available, progress toward the vision held by proponents will be slow indeed" (p. 11).

Brandt (1995) compared the current situation in US education to Alvin Toffler's prediction in Future Shock (1970) that we could expect waves of change to come faster and faster. But he noted that at the present time, although a relatively small number of schools have the equipment and knowledge to send E-mail to people in other countries, consult CD-ROMs for information, and prepare multimedia reports, the vast majority "still do not have access to the newest technologies - and even those who do, tend to use them in conventional ways" (p. 5).

Reporting on an interview with Chris Dede, O'Neil (1995) warned that if technology is used simply to "automate traditional models of teaching and learning" (p. 6), then it will have very little impact on the future of education. In responding to O'Neil's questions, Dede commented that he preferred to refer to the information superhighway as the "information infrastructure" (p. 6). "If we just use it as a bigger pipe to shovel more data through - which is what the superhighway concept conveys - we won't see very much value added" (p.8).

Sullivan (1995) cautioned that the political and economic implications of educational technology are momentous. Educators and administrators, as well as telephone and cable providers, publishers, and state departments of education, all realize the possibilities of lost jobs and lost power should any group gain undue influence in controlling content and transmission (p. 2).

D'Ignazio (1994) warned teachers that they are at a fork in the road. He predicted that the same changes that are affecting non-educational jobs today will begin hitting education soon. There is a strong possibility that "machines can provide higher student-achievement outcomes than flesh-and-blood teachers for a fraction of the cost" (p. 52). But teachers who prepare themselves will find an exciting new place in this dramatically altered workplace of the future. Technology offers opportunities to upgrade their own skills and qualifications and become an integral part of the changing landscape of education.

In Silicon Snake Oil, (1995) Stoll warned of some problems with the new technology. He pointed out that in some cases students spend most of their time learning tools, rather than concepts, and that students who spend their time learning how to access

multiple electronic sources for information may not learn to use that information to make critical decisions.

> . . . isolated facts don't make an education. Meaning doesn't come from data alone. Creative problem solving depends on context, interrelationships, and experience. The surrounding matrix may be more important than the individual lumps of information. And only human beings can teach the connections between things. (p.134)

In his review of Stoll's book, Hurst (1995) predicted that "virtual teaching (using technology) may result in virtual learning - a situation in which neither the instruction nor the learning connects with reality." He agreed with Stoll that "there is no substitute for human interaction in the teaching and learning process" (p. 53).

Miller and Olson (1995) urged long-term research on the effects of technology in education. "Teachers need time to grow in their use of technology, and how they use computers during the initial period may not be indicative of long-term application" (p. 74). Teachers must exercise caution as they consider how technology steers curriculum, the trade-offs in integrating technology into the curriculum, and what will be the unintended results of the new methods.

Lester (1995) asserted that budget allocations must support the new technology. He also compared teacher training to that of doctors or professional athletes, pointing out that they need hands-on experience and mentors, not lectures and books on theory. The schedule needs to be reworked; "the school day, week, and year need to be re-shaped fundamentally to reflect reality" (p. 3).

Latif and Ehlman (1995) studied the use of Computer Aided Design (CAD) software packages in high schools and found that opportunities were still limited due to the large number of students and few computers available in drafting classes, a lack of CAD-trained instructors, and short meeting times for classes.

As has been demonstrated by the emergence of new technologies in the past - television in the 1960's, computers in the 1970's, videodisc and artificial intelligence in the 1980's - technology does not necessarily bring about educational reform. Means, et al. (1995) reported that when technology is used in ways that are compatible with student learning models it "supports exactly the kinds of changes in content, roles, and organizational climate that affect the reform movement" (p. 10). It can also support teacher activities needed to promote this kind of student learning. Technology serves the goals of education reform by contributing to:

- Student learning through involvement with authentic, challenging tasks;
- New roles for students and teachers;
- Professionalization of teachers;
- Creation of a culture that supports learning both in the classroom and beyond the school walls (Overview of Technology and Education, 1995).

Technology lends itself to student-driven collaborative projects. Quesada (1995) described an annual conference on Project-Based Education where the possibilities and challenges of this innovative approach to learning are explored. Students participate in inquiry-based research and cooperative learning that simulates real world applications in the workplace. Teachers are faced with the challenge of evaluating and assessing student learning in areas where they have limited experience and expertise

In describing the integration of technology into the curriculum at the Berkshire School in Canaan, NY, Richman (1995) said his plan developed from inspiration derived from a trip to the local mall where he observed his son as he developed a spontaneous partnership with an older boy to complete a task together in playing a video game. He had also experienced success in allowing his younger, learning-disabled son use a calculator and an electronic speller to build on his own strengths. In recognizing the power of technology, he set about to change the mindset of the staff of the school, select the appropriate hardware and software, and solicit the funding for the desired changes (p. 74).

Changing the mindset of the staff is the subject of considerable concern. Rutherford and Grana (1995) wrote about adapting faculty attitudes and practices to accommodate the new technology. Sometimes teachers resist the change because they perceive it as relinquishment of control. "Vacating the stage to becoming a facilitator rather than the font of learning may seem counterproductive and rather bland" (p. 82). Some other fears experienced by faculty may include fear of change, fear of time commitment, fear of "techno lingo." fear of "techno failure," fear of not knowing where to start, fear of being married to bad choices, fear of having to move backward to go forward, and fear of rejection or reprisals.

Portz (1995) described a project in which industry partnered with education in the Summer Industrial Fellowship for Teachers (SIFT) to "give math, science, computer, and technology instructors real world experiences in industry. . . with the ultimate goal of increasing the number of students opting for careers in technical areas" (p. 39). Portz used his knowledge of Computer Assisted Design (CAD) to draw fixtures for parachute

refurbishment at the Kennedy Space Center. He was able to update and validate his own technical skills as well as bring real world industrial problems into the classroom.

Technology can play an important role as communities begin the process of education reform. "From telephone answering devices and fax machines to the most advanced computers and laser disc players" (Office of Educational Technology, 1995, p.1), technology can help communities and schools structure high-tech learning environments to help all children reach high standards.

Planning for, funding, and implementing network technology is a complex task. The development of a plan that encompasses the many emerging technologies and the needs of users presents a tremendous challenge. NASA's Information Infrastructure Technology and Applications (IITA) Program has published a videotape and guidebook to facilitate this process (NASA's IITA, 1995). The IITA is a project of the NASA High Performance Computing and Communications Program (HPCC). Other HPCC projects include:

- NASA-IITA Management - Digital Library Technology (DTL) - Creating electronic multimedia libraries that are easily accessible to large numbers of users.
- Global Learning and Observations to Benefit the Environment (GLOBE) - a worldwide network of students, teachers, and scientists working together via the Internet to study and understand the global environment.
- NetTEAM96 - a consortium comprised of Apple Computer, Asante Technologies, Cisco Systems, Farallon Communications, NETCOM, Netscape, Spyglass/Surf Watch, 3Com and U.S. Robotics, which provides

ongoing product and service donations, price discounts, and technical expertise to NetDay 96 participants.

- Cislunar Aerospace - K-8 Aeronautics Internet Textbook. An electronic multi-media text, teachers' supplement, and student workbook designed for use on the Internet.
- InfoUse - Internet-based Curriculum on Math and Aeronautics for Children with Physical Disabilities.
- Telescopes in Education (TIE) - at the NASA Jet Propulsion Laboratory in Pasadena, California, a program focusing on providing the tools students need to make hands-on discoveries in astronomy and astrophysics.
- ECOlogic - the Earth System Science Community (ESSC) - A project which will create a high school curriculum for earth system science.
- Passport to Knowledge: Electronic Field Trips to Scientific Frontiers via Interactive TV and the Internet. Students will be able to take field trips around the world through the Internet. Live, interactive videos and hands-on classroom activities under development.
- Internet Library Information Assembly Database (ILIAD) - brings the Web to teachers with no Web access. Searches the Web for answers to questions via e-mail.
- Classroom of the Future - Exploring the Environment. Offers "laboratory" experiments using NASA satellite images and other remotely sensed data collected of the earth over the last three decades, with special sections included for students and teachers (IITA, 1996).

IITA has funded 50 projects in 22 states and the District of Columbia. The project has produced two other videotapes: Global Quest: The Internet in the Classroom - a 12-minute format designed to inspire educators to invest effort in technology, and Global Quest II: Teaching with the Internet - teachers telling teachers about the issues and benefits involved in making this tremendous resource a part of classroom curriculum, which is 22 minutes long (IITA, 1996).

NASA Spacelink is linked to the NASA Education Program home page on the World Wide Web which provides links to other on-line educational resources. These include HPCC programs at the NASA Field Centers, Quest on-line interactive projects, and sources of grants for funding Internet connections to schools (NASA Online, 1996).

Technology can be used as a catalyst for changing schools in ways that better support the acquisition of higher-order skills by all students. It develops skills in areas of comprehension, problem solving, composition, and mathematical reasoning that will support both higher education and effective functioning in the real world. (Overview of Technology and Education, 1995).

The most relevant uses of technology are as tools and communication channels. We call these uses of technology "authentic" because students are using them for the same kinds of purposes and in the same ways that adults would use technology outside the school walls.

Authentic tasks usually involve multiple disciplines and are challenging in complexity. The technology use is integrated into activities that are a core part of the classroom curriculum. Technology is treated as a tool to help accomplish a complex task rather than a subject of study for its own sake. Technology skills are acquired as a means

to an end, and students receive practice in selecting and using various technology applications to accomplish a wide variety of tasks (Overview of Technology and Education, 1995).

The kinds of complex, meaningful projects within which authentic technology use occurs require extended periods of time for implementation. They almost always call on skills and knowledge from different disciplines (e.g., mathematics to analyze survey responses or meteorology to consider natural disasters that might strike a city). They are naturally conducive to small group work, with different students performing different functions as on a sports or workplace team, and with the teacher acting as a coach and facilitator for multiple groups. In these ways, such projects exert pressure to break down traditional school schedules of short blocks of time, artificial barriers between what are viewed as separate subject areas, and the boundaries between the classroom and the outside world (Newman, 1990).

Cohen (1995) reported that the Association for Supervision and Curriculum Development (ASCD) has recently established public-access Internet services which include sites that allow teachers to: "1) learn about ASCD publications, programs, products and services; 2) read timely articles from ASCD publications; 3) stay in touch with breaking developments in ASCD's influence-building work on education issues; 4) join ASCD to order publications and products; and 5) make connections to other Internet-based information and services around the world" (p. 3).

Stager (1995) said that "computer-related staff development should immerse teachers in meaningful, educationally relevant projects" (p. 78). The teachers should be encouraged to share their visions, and connect their experience to constructive student

computer use. He offered three strategies for staff development designed to help teachers "fearlessly dream, explore, and invent new educational experiences for their students" (p. 79). These include:

- In-classroom collaboration between teachers and trainers;
- Residential "slumber parties" where teachers come together for a few days leaving behind the pressures of home and school to improve their skills;
- "Build-a-book" residential workshops which involve teachers in a year-long book-writing and programming experience" (p. 81).

Resource guides, in print and on-line, are increasingly available to provide teachers access to professionally developed teaching and learning materials and to help them in the difficult yet essential task of program development (Todd, 1995). Van Dam (1995) pointed out that software can be used for planning, as well as for delivering technology in education. He reviewed several modules which can be used to write lesson plans, develop assessment tools linked to lessons, view and assign resources to the lesson through attached multimedia tools, collect student achievement data, and share information with others. These packages are capable of keeping electronic portfolios of student work, interfacing with parents/guardians, and assisting teachers with the correlation and analyses of various data (p. 11).

Kimeldorf (1995) reasoned that on-line learning should be added to the curriculum because it demonstrates the relationship between technology and learning and integrates learning into a larger community. The computer is used as a research tool. Students can connect with databases of information available on-line, such as encyclopedias, newspapers, magazines and exhibits. Also human sources are available for on-line

conferencing and E-mail interviews (p. 26). She gave examples of ways to use technology for integrated studies and developing a final product such as videotapes, desktop-published books, and hypertext documents filled with letters or essays collected from on-line exchanges.

Students at risk who are in danger of becoming disengaged from school or mainstream life can make new contacts, develop positive friendships, and build pathways that reconnect them with real world culture. This demonstrates the "healing potential of the virtual community of cyberspace" (p. 27). "When students log on, their socio-economic, geographic, or handicapping condition is no longer relevant" (p. 31).

The Internet makes it possible for educators to locate information sources on a discipline or on teaching in general and to correspond with other educators with similar interests around the world (Peha, 1995). They can incorporate some of the activities found on-line into lessons, thus advancing their professionalism. In the classroom, the "teacher becomes more of a facilitator, helping students find information and, more importantly, figuring out what to do with it" (p. 21). As a result, students are encouraged to work in teams, and more likely to consult with peers than the teacher.

Teachers, however, continue to need preparation and support. "Because Internet tools and resources are constantly changing, teachers must have the ability to adapt" (p. 23). Ongoing support is important. Teachers most often turn to their fellow teachers for help, with the centralized support staff a close second. "Widespread adoption [of technology] is possible only if teachers help one another; a centralized support staff can't be everywhere" (p. 23). Other helpful ongoing technical assistance should include

classroom visits by Internet instructors, monthly meetings of Internet users, and on-line support.

Parents can become more closely involved with their children's education with the help of computers. Students can teach parents, which can greatly boost a student's self-esteem. Familiarity with information technology can lead to jobs, so "schools may also want to expand their efforts to train neighborhood adults after school hours" (p. 21). "Thirty-five percent of U.S. households now have computers, and those with children are more likely to have computers than those without, even families on a somewhat limited budget. Of households with children and total annual incomes under $30,000, over 30 percent have computers. Given that consumer spending on home computers now exceeds spending on televisions, these percentages should continue to rise quickly" (p. 21) Some states and municipalities are bringing network capabilities to all of their citizens. In Seattle, for example, all citizens will be able to communicate over the network by getting a cost-free account from the city, and using it at home or in libraries and other public buildings (p. 21).

Predictions for the future include Asynchronous Transfer Mode (ATM) technology which will better support applications where intermittent disruptions are noticeable to the user, like using a telephone; playing interactive games with a distant player, or controlling a laboratory experiment at a remote site. ATM networks will also transmit data at a rapid rate, allowing users to watch broadcast-quality video on demand, quickly retrieve a series of images from the Space Shuttle's telescope, read the complete works of Shakespeare, or use sophisticated visualization tools to watch changing weather patterns in the area.

According to Peha (1995), the biggest obstacle will continue to be money. "To reduce installation costs, new schools should be wired for computers and networks when they are built, just as commercial office spaces are. Districts should hire staff who can help schools build and troubleshoot computer and network systems" (p. 25).

"President Clinton wants every classroom to be hooked up to the information superhighway by 2000" (Teachers Sought, 1996, p. D5). As of October 1995 about half the country's public schools were linked to the Internet -- up from 35 percent the year before. But only about 9 percent of the individual classrooms had access.

Movements are underway to ensure Internet connectivity for schools. For example, NetDay96 is a grass-roots effort to wire schools so they can network their computers and connect them to the Internet. The goal is to get at least five schoolrooms and a library wired in every school the United States this fall (1996). NetDay96 currently involves over 1,300 sponsors, 5,400 volunteers, and 3,700 organizers. Over 2,000 schools and libraries have already been wired in Connecticut. Similar efforts are underway in Delaware, Massachusetts, and California. In October 1996 "NetDays" to wire schools were scheduled in at least 35 states.

"Once they've found each other, schools and communities can go beyond NetDay96's focus on wiring. It's not NetDay96 that puts computers and software into classrooms, brings technology to students and teachers, or provides training that lets students and teachers reach deeply into the wealth available to them on the Internet. It's the school communities that NetDay96 creates that can put the power of communications technology into every school in the country" (NetDay96, 1996). Some of the resources available through NetDay96 include Web sites such as NetDay96 Bargains, which offers

products at special discounts to educational institutions, and NASA - a "*huge* site with a detailed list of Internet educational resources around the world . . . for every age and level of experience" (NetDay96, 1996).

Services available on the NetDay96 home page include: free web pages on-line with easy to use creator and editor; free E-mail accounts and Web space for individual students and classes as a whole; affordable, highly scaleable Internet connectivity solution for schools based upon the networking concepts developed under the NASA K-12 Internet program; and Internet related services such as low-cost Internet connectivity, content filtering, virus protection, access control, and workstation and notebook security.

Content filtering is a particular concern to parents and educators as schools are connecting to the Internet. "Effective filth filtering and unwholesome site identification requires word reading technology as well as a proximity logic device," says Pepperdine University Internet researcher, Dr. Ogden M. Forbes (NetDay96, 1996).

NetDay96 and other similar models provide a plan for communities who realize that it takes a whole village to educate a child. The responsibility for providing relevant educational experiences and the tools to prepare students for the school to work transition should not fall solely on the shoulders of the classroom teachers.

A study was done in a rural school in Vermont which was the recipient of a generous trust fund established exclusively to bring technology into the learning and teaching experiences of the students, staff, and community. In this case, where funding was not an issue, they set out to transform the school into a true learning center with access to information resources typically unavailable to elementary schools in rural areas. The planners sought to provide students with opportunities to interact in "real time" with

other students in other localities. In alignment with the National Education Standards, the teachers were determined to enable students to become collaborative workers, critical thinkers, and evaluators of information, especially as the learners gained access to a wealth and variety of internal and external data sources. Among their goals was to "empower students to work at deeper levels of reflection, creativity, skill development, and presentation as they apply their academic potential" and to "enhance the effective reinforcement of basic skills through student use of application software and programming that focus on student creation" (Buckley, 1995, p. 66).

At the same time, an effort was made to enable teachers to develop new instructional practices as they experimented with its potential as a pedagogical tool and increase internal school communication, thus increasing professional dialogue among teachers. It was also important for the community to transform the school into a center for technology education and learning in general.

The results of the study were positive. The effective use of educational technology fostered development of a workshop environment in all classrooms. It afforded teachers the opportunity to plan a number of activities at the same time. The students were more eager to participate in group and teamwork. More in-depth research, cooperative learning, and knowledge-based exchanges were conducted among teachers and students. Student writing increased; a heightened focus on revision and editing was created; and student work was published more frequently. Students took greater pride in their work and were more willing to spend time revising it; improved self-esteem was evident. The availability of technology facilitated student ability to get their ideas out on a page and freed them to write. It provided power of authorship, a sense of control, and a heightened

sense of involvement in their own learning. Student research was extended beyond the four walls of the classroom and each classroom was transformed into a true learning center.

Teachers noticed an increase in internal staff communication. Individuals with an affinity for technology emerged and became coaches for their colleagues. The teachers were able to develop professional presentation skills. "Every school or district wants articulate educators who can speak to the methodologies and goals of instruction" (p. 66). Technology became an avenue for the school to solidify its bonds with the community and to become a true town resource in the eyes of the community. "Technology in the school should be as common as the pen and pencil in the daily work lives of students and teachers" (p. 66).

"Technology dramatically change[s] the role of teachers. Rather than the deliverers of information and assessors of students' reservoirs of stored factual information, teachers become the facilitators of learning - the coach that guides students to discover new areas, to ask probing questions, to question information found, to develop new theories and search for information that supports and refutes these theories" (p. 82). Teachers cannot be merely tour guides showing students all there is to see along the Information Highway. They must help students learn to narrow their search for information and evaluate the information they find, while still providing students with the opportunity to explore and discover new areas of learning along the way. This is perhaps the hardest kind of teaching. "Based on a new technology-based paradigm in which the teacher's role is management of a multiple learning source system, the teacher becomes an information resource and mentor" (Ahearn, 1995). The many advantages of using

technology for educational restructuring include: (a) increased planning time for teachers; (b) creation of an active student learning role; (c) individualized learning that eliminates student tracking systems; (d) a focus on outcomes rather than input; and (e) increased opportunities for professional growth.

Teachers need support as they learn to use the tools and incorporate them into their teaching strategies. They did not grow up with technology. They need to learn to use these tools too. Educators must possess the ability themselves to navigate carefully through the almost infinite amount of information and they must have time to develop new teaching strategies that incorporate technology and information highway tools. We need leadership from administrators, parents, and the community to make access to technology and the information highway a priority, to secure and allocate the funds needed for equipment, and to provide the needed time for teachers to learn and share their methods. "You can't just give people computers and expect them to know how to use them [as instructional tools] well. You must give teachers time to work on the computers. This is almost never done" (Manual & Norman, 1992, p. 82). "While this clearly requires a significant amount of funding, the cost of failing to educate our children with the tools of their day is far greater" (Alden & Curyea, 1994, p. 5).

"Technology will never take hold with students unless teachers become skilled with computers and able to teach technology to the students. Only with personal experimentation and practice will teachers feel truly comfortable leading students into their own daily encounters with the power of computers. Teachers need to be provided with the tools necessary to develop this skill and familiarity: such as laptop computers for use at school and at home" (Buckley, 1995, p. 6).

Lazarus and Lipper (1994) found that every child should have access to emerging information technologies because the quality of life of children in America will be affected by them. They noted that "most American children do not have the skills they will increasingly need for the job market they will face" (p. 4). Children from affluent families benefit because their parents are supplementing the information technology education that they receive at school. The best way to assure that every child is taught technological skills is through the American school system. Most children are likely to experience the widest range of new media in the home, where the quality of the content cannot be assured; new media bring new threats to children. The commercial marketplace cannot be counted on to take into account the best interests of children, particularly low-income and minority children, and females. A concentrated effort needs to be made to develop a comprehensive plan of action to make the new information technologies responsive to America's children (p. 6).

During his campaign for re-election, President William Clinton urged federal and state regulators to give all schools and libraries free access to basic Internet services. "President Clinton also announced he would propose spending $100 million next year on the software and wiring to begin connecting 100 major universities and national laboratories to the 'next generation' Internet" (Page, 1996, p. 2A). He was joined by a new commission of corporate executive officers (CEOs) who promised to help provide computers, software, connections to the Internet, and teacher training to every school in the nation.

Summary

Mehlinger (1995) said, "Today there are no learned people, only the learning and the slipping-out-of-date" (p. 20). Lifelong learning is essential, and technology makes it accessible. Educational technology is a dynamic field that changes dramatically with each passing day. Legislation and policy are being enacted to encourage funding for the necessary improvements in access to hardware, software, and telephone lines in our classrooms. Standards are being formulated on the Federal, State, and Local levels as a means to ensure the integrity of the curriculum and the resources available in the classroom. When technology enters the classroom it can expand the learning community beyond the walls of the classroom. Technology can support education reform, but teachers must become comfortable with the technology; receive training, tools, and technical assistance; and embrace education reform which changes the role of the teacher. Reform introduces "authentic" group-oriented activities, and provides the ability to guide students through vast quantities of information. It develops critical thinking skills, and new ways to assess student learning. More funding, time and policies may lead to this education reform, but we are not there yet. NASA Spacelink is one of the many resources available to educators, providing them with access to the Internet, news, authentic opportunities, curriculum pieces that meet national standards, training to use the new technology, and a way to network with other teachers all over the world who are facing the challenges of systemic change. The effectiveness of educational technology will depend on the way it is implemented. If teachers use the new tools to do the same old things, progress will not occur. Teachers must avail themselves of professional

development opportunities, which are becoming more abundant and of higher quality. The new technology must bring with it a reform in the way classrooms are structured, the way students learn, and the way teachers teach.

Research Questions

This study was designed to determine the answers to these questions:

1. Describe the use of NASA Spacelink by holders of Spacelink Educator Accounts in terms of access: availability of technology, frequency of use, duration of connection, and services utilized.
2. Describe financial, technical, and staff development support for Spacelink use.
3. Describe teacher and student use of Spacelink's Aerospace curriculum support: Teacher Guides, files, images, and software downloaded.
4. Determine whether Spacelink use by teachers is related to their exposure to NASA-related conferences and workshops on aerospace education.
5. Describe the education level of the teachers who are using Spacelink Educator Accounts.

CHAPTER III

METHODOLOGY

Introduction

This descriptive study involves collection of data to answer questions concerning the use of aerospace activities in the classroom by teachers who have access to NASA Spacelink. The information will be used in evaluating the effectiveness of Spacelink as an enabling system for dissemination of NASA information as outlined in the NASA Strategic Plan (p. 23) and NASA's Strategic Plan for Education (p. 23 and 38). In this self-reported study, data was collected using a questionnaire which was validated by a panel of Aerospace Education Specialists and was distributed to the subjects by way of electronic mail. The responses were returned electronically, as well.

This chapter explains the methodology of the study and describes the population represented by the sample including the size and major characteristics. The development of the instrument is explained, including a description of its purpose and context plus its validation and reliability. The research design and procedure are clarified and a description of control procedures is provided.

Selection of the Sample

The population for the study consists of the educators who are registered users of Spacelink Educators Accounts. These teachers are located across the United States and are teaching in many different kinds of schools including: rural, urban, public, private, and parochial schools. The grade levels being taught vary from elementary through college level. A few of the Spacelink users are supervisors or administrators who no longer have daily classroom responsibilities. For the purposes of this study, the sample consists of those Spacelink users who have spent 25 hours or more logged on to the system as of January 13, 1996. This criteria was suggested by the Spacelink Administrator as being representative of regular users who have demonstrated more than a casual interest in the on-line resource. At the time of the study, 96 teachers were in this category. They were each sent a survey. Surveys were returned by 94 teachers.

Research Instrument

The instrument was a survey consisting of 20 questions (Appendix A). The survey was distributed on-line and responses were returned on-line by way of E-mail. The responses were mostly multiple choice, but some of the questions provided spaces for explanations and comments. It was designed to describe how teachers who have registered for Spacelink Educator Accounts use Spacelink, what ways they use aerospace education activities in classrooms, and what changes they recommend for increasing effective use of Spacelink in the future. Follow-up contacts were made by E-mail, then by telephone and regular mail. The survey was validated using a field test involving NASA Aerospace

Education Specialists who have been trained extensively to use Spacelink and who regularly conduct Spacelink training workshops for educators. These individuals were asked to respond to the survey as if they were research subjects, and to offer criticism and suggestions for improving the survey before it went out to the actual subjects.

Research Design and Procedure

This study was designed to answer the research questions developed from the Review of Literature in Chapter II:

1. Describe the use of NASA Spacelink by holders of Spacelink Educator Accounts in terms of access: availability of technology, frequency of use, duration of connection, and services utilized.
2. Describe financial, technical, and staff development support for Spacelink use.
3. Describe use of Spacelink's Aerospace curriculum support: Teacher Guides, files, images, and software downloaded.
4. Determine whether Spacelink use by teachers is related to their exposure to NASA-related conferences and workshops on aerospace education.
5. Describe the education level of the teachers who are using Spacelink Educator Accounts.

The answers to these questions provided information that will assist in evaluating the effective use of NASA Spacelink by educators. A pilot study was conducted whereby the instrument was tested on Aerospace Education Specialists who are Spacelink users and who are familiar with the system. They were asked to respond to the survey, as well

as to critique it as to appropriateness of the questions, clarity of the language, and motivation for its return. Their responses were used to determine content validity (sample and item validity), internal consistency, and scorer/rater reliability for the survey. The acceptability criterion for the reliability coefficient for this study was .80. Interjudge and intrajudge reliability were established based on 80% agreement.

Permission to perform research involving NASA Spacelink was obtained from Mr. Jeff Ehmen, the Center Education Programs Officer at Marshall Space Flight Center in Huntsville, Alabama, with whom the ultimate responsibility for the operation of Spacelink rests. The study was also approved by the Institutional Review Board at Oklahoma State University, Stillwater, Oklahoma, where the study was conducted (Appendix B).

Ninety-six surveys were mailed electronically in February, 1996. Follow-up reminders were E-mailed to nonrespondents in the form of a duplicate mailing of the survey after four weeks. Further follow-up included surveys sent by U.S. mail, FAX, and telephone calls. Ninety-four responses were returned by electronic mail.

Analysis of Data

Upon receipt of the returned questionnaires, the data were coded and entered into a Microsoft Excel spreadsheet which was then transferred to STATPAK for statistical analysis. Frequency counts were tabulated for each question and percentages were computed for the total returned questionnaire population. The responses were analyzed by the researcher. Attention was given to the relationships of individual responses as they related to the research questions.

Summary

In summary, this chapter gives a description of the design of the study. Major areas discussed were a description of the purpose of the study, the sample, collection of data, scope and validity of the instrument, and method of analyzing data.

CHAPTER IV

RESULTS OF THE STUDY

Introduction

The first three chapters of this study gives a general introduction to the study, a review of related literature, and a discussion of the design of the study. The information in this chapter is a presentation of the findings from the Survey on Spacelink Educator Use. Data obtained from the questionnaire are discussed and analyzed. The data are presented in two sections.

The first section contains responses to the questionnaire items. The frequencies and percentages in that section are concerned with:

1. How educators access Spacelink;
2. The number of times educators log on to Spacelink per week;
3. The average length of a Spacelink connection;
4. Which Spacelink services are used by educators;
5. Which Spacelink services are used by students;
6. The number of files downloaded from Spacelink;
7. The availability of Spacelink in schools and the location of computers within the schools;
8. The number of computers in classrooms;

9. The funding sources for the cost of Spacelink;

10. The availability of staff development training in the use of on-line resources;

11. Whether there is a school computer contact person for staff development and/or for technical assistance;

12. The amount of time schools are open after school hours and on weekends for computer access;

13. Whether aerospace activities are included in the curriculum;

14. Whether aerospace activities were used before access to Spacelink;

15. The influence of Spacelink on the use of aerospace activities;

16. The number of aerospace activities added to lesson plans;

17. The number of NASA Teacher Guides accessed;

18. The number of aerospace conferences/workshops attended;

19. The highest level of education achieved by the respondents.

The data in the second section are presented in response to five research questions which arose as a result of: (a) concerns expressed by Spacelink administrators about usage patterns and abuse of privileges by Spacelink Educator Account holders; (b) questions raised by Aerospace Education Specialists as to the effective use of Spacelink by teachers; and (c) the absence of prior studies about the use of NASA Spacelink as an on-line resource for educators, which was revealed in the review of literature in Chapter II. The research questions are:

1. Describe the use of NASA Spacelink by holders of Spacelink Educator Accounts in terms of access: availability of technology, frequency of use, duration of connection, and services utilized.

2. Describe the financial, technical, and staff development support for Spacelink use.
3. Describe teacher and student use of Spacelink's aerospace curriculum support: Teacher Guides, files, images, and software downloaded.
4. Determine whether Spacelink use by teachers corresponds to their exposure to conferences and workshops on aerospace education.
5. Describe the education level of the teachers who are using Spacelink Educator Accounts.

Responses to the Questionnaire

A list of the E-mail addresses of registered Spacelink users who had logged on to the system for twenty-five hours or more as of January, 1996, was obtained through the Spacelink Administrator at NASA George C. Marshall Space Flight Center in Huntsville, Alabama. A questionnaire was sent electronically via Spacelink to each of these addresses. Ninety-six questionnaires were sent; 95 questionnaires (97.6%) were returned.

How Educators Access Spacelink

Questionnaire data indicated that 88.2 percent of the respondents accessed Spacelink using the toll-free number provided by NASA. A direct dial modem was used by 6.4 percent of the users; 4.3 percent responded that they used other methods, for example, university library systems; and 1.1 percent used a commercial server. A summary of the data obtained in questionnaire item one is given in Table I.

TABLE I

METHOD OF ASSESSING SPACELINK ACCOUNT

Access Method	Frequency	Percent
Toll-Free Number	83	88.2
Commercial Server	1	1.1
Direct Dial	6	6.4
Other	4	4.3
Total	94	100.0

The evidence indicates the majority of the most frequent Spacelink users are taking advantage of the opportunity to use the toll-free number at the expense of NASA. This implies teachers recognize the value of the toll free access, and if the toll-free number was not provided, Spacelink usage would sharply decline.

Future research should include questions concerning awareness, availability, and cost of local Internet connectivity. Subjects should be asked if they would use Spacelink if there were no toll-free number available.

The Number of Times Educators Log On to Spacelink Each Week

The percent of educators who reported logging on to Spacelink ten or more times a week was 36.6 percent, 33.3 percent had logged on from seven to nine times per week, 24.7 percent had logged on four to six times a week, and 5.4 percent had only logged on one to three times per week. A summary of the data obtained in questionnaire item two is given in Table II.

Well over half the Spacelink Educator Account holders log on an average of at least once a day. This indicates a real commitment to the system, a commitment to acquire data available on the system, and a genuine pattern of use. Future research should inquire as to how many times subscribers log on each day, which days of the week subscribers log on most, and during which hours of the day they log on most often. A longitudinal record of the times and lengths of log on periods would be informative. It would be helpful to know what months or times of the year the teachers log on most, so NASA could better plan special events and opportunity announcements on Spacelink.

TABLE II

TIMES PER WEEK EDUCATORS ACCESS SPACELINK

Times Per Week	Frequency	Percent
One to Three	5	5.4
Four to Six	23	24.7
Seven to Nine	31	33.3
Ten or More	34	36.6
Total	93	100.0

The Average Time Length of a Spacelink Connection

The average time length of a Spacelink connection was reported to be ten minutes or less by 6.4 percent of the respondents, ten to twenty-nine minutes by 52.1 percent, thirty to fifty-nine minutes by 31.9 percent, and 9.6 percent said they averaged an hour or longer on each connection. A summary of the data obtained in questionnaire item three is given in length in Table III.

Less than half of the respondents spend more than 30 minutes per session logged on to Spacelink. Considering that all of them use E-mail, not many of the users are spending enough time logged on during an average Spacelink session to do any lengthy research. It takes time to search for topics, follow links, explore various paths, and read the information or download and print it. If the files contain graphics the process takes even longer. Experienced Internet users know to create "bookmarks" to mark sites where they want to return for more research, which makes the process faster. But a productive research session still usually takes at least an hour. Future research should study the percentages of each session spent on E-mail, Spacelink features, the Internet, and downloading files. It would also be useful to know whether there is a statistically significant correlation between how many times per week users log on and the length of each Spacelink session.

Teacher time on Spacelink is limited by time restrictions of the school schedule. The data indicates the majority of the teachers who use the Educator Accounts have no connectivity at home, so their only opportunity to use the account is during the school day. Since connectivity is still so limited, most connected schools have only one or two

TABLE III

TIME LENGTH OF SPACELINK CONNECTIONS

Time Length of Connection	Frequency	Percent
Less than 10 minutes	6	6.4
10-29 minutes	49	52.1
30-59 minutes	30	31.9
One hour or longer	9	9.6
Total	94	100.0

phone lines which must be shared by the whole faculty and office staff, and most connected computers are not yet in the classrooms where teachers have convenient access, the time they spend on-line is understandably brief. Most teachers do not have the luxury of spending large blocks of time exploring links to various resources. In most cases they must log on, get what they need, and log off. They must have a fairly good understanding of the system to accomplish this.

The survey results support the findings in the review of literature indicating that: connectivity is still in its beginning stages, and that teachers need clear instructions and training and on-site technical support is important.

The Spacelink Services Used by Educators

The responses to the survey revealed that: 100 percent had used E-mail, 83 percent had accessed the Internet through Spacelink, 70.2 percent had used newsgroups, 57.4 percent had used NASA press releases, 51.1 percent had accessed one or more of the Teacher Guides, 47.9 percent had used the "hot topics," 43.6 percent had downloaded software from Spacelink, 33 percent had used the conferencing feature, 33 percent had used the bulletin boards, 27.7 percent had viewed images, and 10.6 percent had used other services including other NASA sites on the Internet, ERIC databases, Listserv, and school websites. A summary of the data obtained in questionnaire item four is given in Table IV. Considering the length of time for Spacelink sessions reported in question two, the data indicates that most of the time on-line is spent reading and writing E-mail. The next most frequently used service is the Internet. It is apparent from their responses that some of the frequent Spacelink users are using the toll-free number as a way to access the other

TABLE IV

EDUCATOR USE OF SPACELINK SERVICES

Services	Frequency	Percent
E-Mail		
Yes	94	100.0
No	0	0.0
Conferencing		
Yes	31	33.0
No	63	67.0
Bulletin Boards		
Yes	31	33.0
No	63	67.0
Newsgroups		
Yes	66	70.2
No	28	29.8
Hot Topics		
Yes	45	47.9
No	49	52.1
NASA Teacher Guides		
Yes	48	51.1
No	46	48.9
NASA Press Releases		
Yes	54	57.4
No	40	42.6
SoftwareDownload		
Yes	41	43.6
No	53	56.4
Images		
Yes	26	27.7
No	68	72.3
Internet		
Yes	78	83.0
No	16	17.0
Others		
Yes	10	10.6
No	84	89.4

information available on the Internet and may not be using the service to enhance their use of Spacelink-provided aerospace activities and information in the classroom. Although access to the Internet is something every teacher should have, it is not the main objective of NASA Spacelink to provide this service. However, for most teachers, Spacelink Educator Accounts are their first introduction to the Internet. It is natural that they are primarily interested in the most popular features, and that they want to use the features that are interactive and allow them to network with other educators. As connectivity improves and more teachers have Internet access, more teachers will take advantage of the other resources offered by Spacelink. Future studies will test this prediction.

Future research should include studies of actual time spent using each service. A longitudinal log would be helpful. A computer program could be written to track the times without violating any individual's right to privacy.

The Number of Files Downloaded from Spacelink

In response to a question asking how many files had been downloaded, 26.9 percent of the educators reported that they had not downloaded any files from Spacelink, 36.5 percent had downloaded ten or more files, 18.3 percent had downloaded from one to three files, 11.8 percent had downloaded from four to six files, and 6.5 percent had downloaded from seven to nine files. A summary of the data obtained in questionnaire item five is given in Table V.

TABLE V

NUMBER OF FILES DOWNLOADED FROM SPACELINK

Number of Times Downloaded Fiels	Frequency	Percent
None	25	26.9
One to Three	17	18.3
Four to Six	11	11.8
Seven to Nine	6	6.5
Ten or More	34	36.5
Totals	93	100.0

The noticeable tendency to the extremes on this question was probably because people who know how to download do it frequently, but downloading is a skill which many people still have not acquired. Downloading often requires technical assistance on the school site. Seven respondents expressed frustration and disappointment at not being able to download software or files using the PINE[a] program, and there were comments about the text-only Telnet system. These comments included:

- "can't figure out how to download or would use that;"
- "HOW DO I DO THIS? Do we have GIF ability?;"
- "I do not do this because I do not know how to do this. I have tried MANY times to have someone explain how to do this with no success?;"
- "I am having trouble downloading messages from pine [sic];"
- "I have only a text hookup at this point;"
- "I would like to do this but haven't had success;"
- "I know how to download an image file that has been sent to me as an attachment and save it to my workstation to view later via Microsoft works and JPEG viewer. However, I have no idea how to view an image on URL via the Internet. Is this a text only system? Is there a way to view the planets and other images that are on the Internet;" and
- "This depends on what you mean by downloading. The only time I actually use the download command is when I'm trying to save a picture file to view later. However, I copy and paste articles everyday to my own files. I have hundreds of pages of information I have gathered from Spacelink files."

Because the Spacelink toll-free number uses Telnet, which is a text-based protocol, users are not able to view images on-line. Instead, they must download the image, convert it to graphics using the appropriate type of software, and open it off-line to view or print. The reported confusion, frustration, and difficulty of the downloading process may have affected the number of respondents who used images and downloaded information or software. Several teachers noted in their comments that they would appreciate training in the use of Spacelink, particularly the downloading process. The on-line help on downloading and viewing graphics files should be made more specific and user-friendly for teachers who have little experience with computer use. Providing point-to-point protocol (PPP) access with a toll-free number for educators would eliminate the problem. It is encouraging to note that nearly 75 percent have tried downloading with some success. This number will increase with availability of hardware, connectivity, and technical support.

The Accessibility of Spacelink in Schools

Seventy-one percent of the teachers have access to Spacelink in their schools. 21.5 percent do not, and 7.5 percent answered that the question was not applicable to them. One person commented that he had access at only one of the two schools where he worked. A summary of the data obtained in questionnaire item six is given in Table VI.

The respondents reported that a significant number of schools have access to Spacelink. Future research should inquire how many of the teachers are able to access Spacelink at home. A substantial number of teachers who access Spacelink at home using the toll-free number who may not be able to use the service at school.

TABLE VI

SPACELINK IN SCHOOLS

	Frequency	Percent
PART 1: SCHOOLS WHICH HAVE ACCESS TO SPACELINK		
Yes	66	71.0
No	20	21.5
NA	7	7.5
Total	93	100.0
PART 2: LOCATION OF COMPUTERS WITH SPACELINK ACCESS		
Classroom	24	30.8
Main Office	8	10.4
Library or Media Center	26	33.8
Computer Lab	11	14.3
Other	13	16.9

Without the toll-free access, these teachers would be forced to use personal funds to pay for connectivity. This could cause a decline in usage.

The seven respondents who answered that this question did not apply to them were school administrators or university professors who are not located in a traditional K-12 school environment.

The Spacelink toll-free accounts were designed to bridge the gap for teachers who had not yet acquired local low-cost connectivity to the Internet in their schools. The responses from the survey indicate that this connectivity is being accomplished very slowly. In order to access Spacelink, even with the toll-free number, the teachers need a computer with enough space on the hard drive and memory to handle the task, communications software capable of emulating a VT 100 terminal, a modem, and a dedicated phone line. Future studies should include an inquiry about the number of phone lines available in the school to support modem communications. In many communities the teachers will continue to need toll-free connectivity because local area access is extremely limited.

Of those who responded affirmatively, 30.8 percent have computers with Spacelink access in their classrooms, 67.9 percent do not, and 1.3 percent said the question did not apply. 10.4 percent of the respondents answered that their computers were in the main school office; 33.8 percent said their computers were in the library or media center; 14.3 percent access Spacelink from the computer labs in their schools; and 16.9 percent answered that their school access to Spacelink was somewhere other than the listed choices, including their district central office, the gifted and talented lab, the

professor's private office, on a movable cart, other classrooms, and the faculty lounge. Some listed positive responses to more than one choice.

Less than one third of the teachers have computers in their classrooms with Spacelink access. In question eight, we see that nearly 15 percent have no computers at all in the classroom. Schools still have so few computers that they are placing them in a central location such as the library, media center, or a computer laboratory to facilitate equitable availability to the entire school population. This limits spontaneous usage of computers for research, writing, and extra projects by teachers and by students. It also supports the findings of time usage of less than one hour per week. If connectivity was better, increased usage could be expected. In question twelve we see that less than half the respondents have students using Spacelink. The location of the computers could be a factor in this case. Only about 35 percent of the schools have enough computers in the classrooms where teachers and students can access Spacelink or the Internet as easily as they could refer to a reference book; using the media center or computer lab often involves advance scheduling and logistical problems.

The Sources of Funding for the Cost of Spacelink

According to 95.7 percent of the respondents, the cost for their Spacelink access was paid by the toll-free educators' account. The 4.3 percent who answered "other" listed their business, the Federal Government, and the University of Southern Mississippi. A summary of the data obtained in questionnaire item seven is given in Table VII.

TABLE VII

SOURCES OF FUNDING FOR COST OF SPACELINK

Spacelink Cost Paid By	Frequency	Percent
Toll-Free Educator Account	88	95.7
School System	0	0.0
State	0	0.0
Personal	0	0.0
Other	4	4.3
Totals	92	100.0

The responses to this question show a correlation with the responses to survey item one. Educators do not seem to be inclined to spend personal funds on connectivity to the Information Highway. Future research should determine whether teachers are aware of other sources of funding for school connectivity, the cost of using local commercial servers, and what the attitudes of teachers are about spending personal funds to get connected.

The Number of Computers in Classrooms

The number of teachers who answered that they have only one computer in their classrooms was 26.6 percent, 25.5 percent had from two to five, 7.4 percent had from six to nine, 9.6 had ten or more, 14.9 percent reported not having any computers in their classrooms, and 16 percent said the question was not applicable. A summary of the data obtained in questionnaire item eight is given in Table VIII.

Computer use in classrooms is far from prevalent at the present time. Further, possession of the hardware does not ensure its effective implementation. Future research should inquire as to the make, model, age, and capabilities of the computers in the classrooms. If the computers are older models they may not have communications capabilities. If their disk space is limited they may not be able to handle the storage requirements for software and electronic communications. If their operating systems are not user-friendly, teachers and students may find them intimidating or threatening, and they may not be making use of their potential as a resource. Respondents should also be asked whether the computers in question are equipped to communicate with Spacelink, and whether the teachers are comfortable and confident in using them. "Technology is

TABLE VIII

NUMBER OF COMPTUERS AVAILABLE IN CLASSROOMS

Number of Computers Available	Frequency	Percent
Zero	14	14.9
One	25	26.6
Two to Five	24	25.5
Six to Nine	7	7.4
Ten or More	9	9.6
Not Applicable	15	16.0
Totals	94	100.0

only as good as the purpose it's serving. Training is a big component" (Rosenberg, 1996).

Training in the Use of On-line Resources

Of the respondents reporting, 48.9 percent have been trained in staff development sessions to use on-line resources, 51.1 percent have not. A summary of the data obtained in questionnaire item nine is given in Table IX.

Fewer teachers have received training in staff development sessions for using on-line resources than have not. Future research should establish whether or not this type of training is available at all. It would be useful to know whether the training is mandatory or optional, whether other sources of training are available and are being used, and how teachers feel about becoming trained to use educational technology. It is important to learn whether teachers see technology as yet another task being added to their already overfilled schedules, or as a way to expedite and enhance the work they are already doing.

The Availability of a School Computer Contact Person for Staff Development

Of the teachers responding to the survey, 50.6 percent have a computer contact person available for staff development and training, 43 percent do not, 3.2 percent don't know, and 3.2 percent report that the question is not applicable. A summary of the data obtained in questionnaire item ten is given in Table X.

Over half the respondents are aware that a person on their staff is knowledgeable about computers and whose responsibility it is to impart that knowledge to

TABLE IX

TRAINING IN THE USE OF ON-LINE RESOURCES

Trained in Staff Development to Use On-Line Resources	Frequency	Percent
Yes	46	48.9
No	48	51.1
Totals	94	100.0

TABLE X

SCHOOL COMPUTER CONTACT PERSON FOR STAFF DEVELOPMENT

School Computer Contact Person for Staff Development	Frequency	Percent
Yes	47	50.6
No	40	43.0
Don't Know	3	3.2
Not Applicable	3	3.2
Totals	93	100.0

the rest of the school staff. Considering the responses to question nine, it would be useful to engage in additional research to determine why, because the training is available, it has not been accomplished. Future inquiry should be pursued to learn the reasons for this situation.

The Availability of a School Computer Contact Person for Technical Assistance

Sixty-three percent of the respondents reported having a school computer contact person available for technical assistance, 32.6 percent do not, 2.2 percent do not know, and 2.2 percent felt the question was not applicable. A summary of the data obtained in questionnaire item eleven is given in Table XI.

Schools are more adequately staffed with technicians than with facilitators. Teachers seem to feel that it is easier get their hardware serviced when necessary than it is to get assistance in learning to use it. It would be useful to learn whether those teachers who do not have local technical assistance feel that they are inconvenienced by this dilemma. Future research should include inquiries as to where they turn when they need technical help, and whether they would use their computers more effectively if that assistance were available on-site.

Student Use of Spacelink

Of the 94 respondents, 42.6 percent reported that the students in their classes use Spacelink, 38.3 percent said their students do not use Spacelink, and 19.1 percent

TABLE XI

SCHOOL COMPUTER CONTACT PERSON FOR TECHNICAL ASSISTANCE

School Computer Contact Person for Technology	Frequency	Percent
Yes	58	63.0
No	30	32.6
Don't Know	2	2.2
Not Applicable	2	2.2
Totals	92	100.0

did not feel the question applied to them. A summary of the data obtained in questionnaire item twelve is given in Table XII.

Of those who do have students using Spacelink, 73.2 percent have students who use E-mail; 60 percent have students who have used the Internet through Spacelink access; 46.3 percent reported having students who have used news groups; 32.5 percent reported that their students use "hot topics;" 32.5 percent said their students had accessed NASA press releases; 27.5 percent have students who have used images from Spacelink; 24.4 percent of the students have used bulletin boards; 17.5 percent reported that their students have used other services through their Spacelink access, including "Passport to Knowledge,", "Live from the Stratosphere" and "Live from the Hubble Space Telescope," and to search for information for projects; 15 percent of the students have downloaded software; 14.6 reported that their students have used the conferencing feature; 7.5 percent reported that their students had made use of the Aerospace Education Teacher Guides, and one person (2.4 percent) did not think that question was applicable to their situation In their comments, teachers reported student involvement in special projects and programs on-line. "We participated in 'Jupiter On-line' as much as we could. We don't have satellite connections to actually view the NASA stations or view astronauts when they are in space. We also sent questions to 'MARSLINK,' but they were never answered. My students were disappointed. Several NASA specialists, however, tried to answer their questions when we just happened to find them on a conference line one morning." Students, like teachers, are most interested in the interactive features. This will be the case until connectivity improves and they are able to spend more time on-line. Students are generally less timid than teachers about exploring new features like conferencing and

TABLE XII

STUDENT USE OF SPACELINK SERVICES

	Frequency	Percent	Frequency Yes	Frequency No	Percent Yes	Percent No
PART 1: STUDENT USE OF SPACELINK						
Yes	40	42.6				
No	36	38.3				
Not Applicable	18	19.1				
PART 2: SPACELINE SERVICES						
E-Mail			30	11	73.2	16.8
Conferencing			6	35	14.6	85.4
Bulletin Boards			10	31	24.4	75.6
Newsgroups			19	22	46.3	53.6
Hot Topcis			13	27	32.5	67.5
NASA Teacher Guides			3	37	7.5	92.5
NASA Press Releasea			13	27	32.5	67.5
Software Download			6	34	15.0	85.0
Images			11	29	27.5	72.5
Internet			24	16	60.0	40.0
Others			7	33	17.5	82.5

bulletin boards. As teachers become more comfortable with using on-line resources their students will use them more.

The low percentages of student usage could be related to the low number of computers, or to the locations of the computers in the schools. Until computers are located in the classrooms where students may feel comfortable using them spontaneously as a resource or reference without having to make prior arrangements or moving to another physical location, the percentage of student use will not rise. Future research should investigate how many students have Internet connectivity in their homes. It would be interesting to compare the comfort level and confidence in using on-line resources between the teachers and the students.

Computer Availability after School Hours
and on Weekends

In relation to having the school open after school hours and on weekends to allow accessibility to the computers by students, teachers, and members of the community, 33.8 percent of the respondents reported that their schools are not open after school hours, and 15.7 percent said that their schools were open for one hour after school on weekdays so that students, teachers, parents or community members could take advantage of the availability of their computer equipment. Of the respondents, 15.7 percent reported that their schools were open for two hours after regular school hours each day; 6.7 percent reported three hours, 13.5 percent four or more hours, and 14.6 percent felt that the question was not applicable to their circumstances

A summary of the data obtained in questionnaire item thirteen is given in Table XIII.

Sports teams practice and play their games after school hours. When it is necessary to open the building at night for PTA meetings or special programs arrangements can be made. When the need for additional time for computer use after hours is strong enough, arrangements will be made for school buildings to be accessible at convenient times for faculty and staff, students, and adults in the community.

Most schools are not open on weekends, according to 83.6 percent of the respondents. Of those that are open, 3.7 percent are open 2 hours per weekend, 10.9 percent are open 4 or more hours, and 1.8 percent (one person) felt the question was not applicable. However, 39 respondents (41.5 percent of the total) did not respond to this part of the question. One person said they have twenty-four hour access to their school, but students and community members do not.

Schools have a great potential to be used as a place for research and discovery. It is unfortunate that these facilities are limited in their usefulness because of the restricted operating hours. This problem has been recognized and remedied in some communities. Many schools are converting to a year-round operating schedule. Some are offering adult classes and computer training at night, on weekends, and in the summer. Initiating programs like these calls for additional staffing and security, but the benefits are considerable. Using the facilities and the costly computer equipment instead of letting them stand idle is more cost-effective, and offers the potential to increase the earning potential and self esteem of under-educated adults in the community as well as the students and teachers in the school.

TABLE XIII

COMPUTER AVAILABILITY

Availability	Frequency	Percent
Availability After School Hours		
Zero	30	33.8
One Hour	14	15.7
TwoHours	14	15.7
Three Hours	6	6.7
Four or More Hours	12	13.5
Not Applicable	13	14.6
Totals	89	100.0
Availability on Weekends		
Zero	46	83.6
One Hour	0	0.0
Two Hours	2	3.7
Three Hours	0	0.0
Four or More Hours	6	10.9
Not Applicable	1	1.8
Totals	55	100.0

Aerospace as Part of the Curriculum

Aerospace is not a part of their curriculum according to 25.2 percent of the respondents; 8.8 said aerospace is taught as a separate subject; 45.1 percent include aerospace in their science curriculum; 2.2 percent include it in mathematics, 11 percent use it in some other way, and 7.7 percent answered that the question was not applicable. Some of the "other" responses included: as part of the Industrial Technology program, Communication, and Space Technology.

One teacher uses aerospace in her third grade reading class curriculum, and one reported using it as part of the Technology Curriculum. Another said their Technology Class uses Spacelink to communicate with scientists at NASA Jet Propulsion Laboratory (JPL). One said they use Spacelink for a weather forecasting program, an IITA K-12 Outreach with NASA Dryden Flight Research Center; one said "I incorporate it into the Earth Science and Astronomy classes I teach;" one uses Aerospace Education to integrate Mathematics, Science, and Language; and one answered "informally included as we find material appropriate to cover." Other comments included: "used as lesson enhancements and gifted/talented activities," and "I use it to teach communication skills." A summary of the data obtained in questionnaire item fourteen is given in Table XIV.

One of the goals of the Aerospace Education Services Program (AESP) is to help teachers learn to use aerospace activities as an avenue to assist in integrating the curriculum. The evidence indicates a need for an increased emphasis in this area. Less than ten percent of the schools teach aerospace as a separate subject. The responses indicated very few schools where aerospace is considered a part of more than one area of

TABLE XIV

AEROSPACE AS PART OF THE CURRICULUM

Aerospace Education As Part of Curriculum	Frequency	Percent
No	23	25.2
Yes, Separate Subject	8	8.8
Yes, as Part of Science	41	45.1
Yes, as Part of Math	2	2.2
Other	10	11.0
Not Applicable	7	7.7
Totals	91	100.0

the curriculum. One fourth of the respondents said Aerospace is not a part of their curriculum at all. This indicates the teachers are not aware of the connections between aerospace and the principles of physics, mathematics, biology, geometry, and many other curriculum areas. Future research should include questions on the teachers' level of awareness of the science and mathematics applications of aerospace concepts, and their attitudes about using these concepts to supplement and integrate these disciplines.

Aerospace Activity Use before Access to Spacelink

The teachers reported that 55.5 percent had used aerospace activities in their curriculum before they had access to Spacelink, 29.3 percent had not, and 15.2 percent felt that it was not applicable. A summary of the data obtained in questionnaire item fifteen is given in Table XV.

This response demonstrates a need for introduction of aerospace activities to teachers as a vehicle for teaching existing curricula. Teachers are wary of "yet another added responsibility on their already overloaded calendar." They are more interested when they can be shown how to use aerospace as a way to make their jobs easier. The high percentage of respondents who answered that this question concerning the use of aerospace activities was not applicable to them may reflect a lack of awareness about the science, mathematics, and technology applications in the field of aerospace. Future research should include questions on the teachers' level of awareness of the science and mathematics applications of aerospace concepts, and their attitudes about using these concepts to supplement and integrate these disciplines.

TABLE XV

AEROSPACE ACTIVITY USE BEFORE SPACELINK ACCESS

Aerospace Activity Use Before Spacelink Access	Frequency	Percent
Yes	51	55.5
No	27	29.3
Not Applicable	14	15.2
Totals	92	100.0

Spacelink Influence on the Use of Aerospace Activities in the Classroom

This question really embodied the most important point in the whole study: "How has your use of aerospace activities in your teaching been influenced as a result of your use of Spacelink?" Of the 30.4 percent of the teachers who had not used aerospace activities in their curricula before accessing Spacelink, 9.8 percent reported that they still do not. 7.6 percent reported that they now do, and 13 percent said they now use them often. Of the 47.9 percent of the teachers who had used aerospace activities before, 1.1 percent said they now use them less, 12 percent said they now use them the same amount, 13.1 percent reported now use them more, and 21.7 percent said they now use them much more. According to 21.7 percent, the question was not applicable to their circumstances. A summary of the data obtained in questionnaire item sixteen is given in Table XVI.

About two thirds of the teachers reported that their use of aerospace activities in the classroom has either remained the same or increased since they have had access to Spacelink. Over half reported an increase.

Of the teachers who did not use aerospace activities before, 19 of 28 (67.9 percent) now do, after accessing Spacelink. Of the 44 teachers who were already using aerospace activities in their curriculum, 32 of them (72.7 percent) have increased that use. This evidence indicates that Spacelink is providing a useful service and is meeting the goals and objectives of Spacelink, of the NASA Education Division, and the agency itself. Future research should involve restructuring this question to better reflect the actual practices and attitudes of the teachers concerning the use of aerospace activities in

TABLE XVI

SPACELINK INFLUENCE ON THE USE OF AEROSPACE ACTIVITIES IN THE CLASSROOM

Influence of Spacelink on Use of Aerospace Activities	Frequency	Percent
Did not, do not now	9	9.8
Did not, do now	7	7.6
Did not, do often now	12	13.0
Did, do less now	1	1.1
Did, do same now	11	12.0
Did, do more now	12	13.1
Did, do much more now	20	21.7
Not Applicable	20	21.7
Totals	92	100.0

their classrooms. The high percentage which felt the question was not applicable indicates a misunderstanding as to the content of the question. The teachers should be given the opportunity to express themselves in a more subjective form.

Number of Aerospace Activities Added to Lesson Plans

Twenty percent of the respondents reported having not added any new aerospace activities to their curricula as a result of their Spacelink use. From one to four new activities had been added by 25.6 percent, 10 percent had added from five to nine, 25.6 percent had added ten or more, and 18.8 percent said the question was not applicable. A summary of the data obtained in questionnaire item seventeen is given in Table XVII.

Over half the teachers report having added aerospace lessons to their repertoire of teaching plans as a result of their access to Spacelink. This information attests to the fact that Spacelink is effective in its task of disseminating NASA resources to the education community. However, the high number of "not applicable" responses implies that these teachers are not aware of the many possibilities of using aerospace activities to integrate the curricula in a variety of disciplines. Future research should study ways in which the service could be enhanced and improved to reach more teachers and better meet the needs of those who are already connected.

Teacher Guides Accessed on Spacelink

In response to a question about having downloaded the four NASA Teacher guides through Spacelink, 39.8 percent reported having downloaded the Rocket Guide, 23.7 percent said they had downloaded Space Based Astronomy, 19.4 percent had

TABLE XVII

NUMBER OF AEROSPACE ACTIVITIES
ADDED TO LESSON PLANS

Number	Frequency	Percent
Zero	18	20.0
One to Four	23	25.6
Five to Nine	9	10.0
Ten or More	23	25.6
Not Applicable	17	18.8
Totals	90	100.0

downloaded the Microgravity guide, and 22.6 percent had downloaded Suited for Spacewalking. A summary of the data obtained in questionnaire item eighteen is given in Table XVIII.

If not for the problems reported earlier with the downloading process, the number of Teacher Guides downloaded would probably have been higher. Also, the "text-only" version of these guides doesn't capture the essence of their quality or their usefulness. Future studies should examine the correlation between the number of guides accessed and the number of users who are using the graphic interface available on the World Wide Web.

NASA-related Conferences or Workshops Attended

When asked about NASA-related conferences or workshops attended, 30.1 percent reported having attended one of the NASA NEWMAST or NEWEST workshops which are held each summer at all of the NASA Field Centers. Of the survey respondents, 26.9 percent said they had attended a national conference of the National Science Teachers Association (NSTA), the National Council of Teachers of Mathematics (NCTM), or the International Technology Education Association (ITEA), 19.4 percent reported having attended a State Aerospace Education Workshop held at a local college or university, 15.1 percent had attended a workshop offered by the National Science Foundation (NSF), and 4.3 percent had attended one of the summer workshops held by the NASA Urban Community Enrichment Program. A summary of the data obtained in questionnaire item nineteen is given in Table XIX.

Past research has indicated a strong interest among workshop and conference participants in NASA materials and publications for teachers (Marks, 1975). Spacelink

TABLE XVIII

TEACHER GUIDES ACCESSED ON SPACELINK

Guides Downloaded	Frequency Yes	Frequency No	Percent Yes	Percent No
Rocket Guide	37	56	39.8	60.2
Space Based Astronomy	22	71	23.7	76.3
Microgravity Guide	18	75	19.4	80.6
Suited for Spacewalking	21	72	22.6	77.4

Note: Respondents marked more than one response when appropriate.

TABLE XIX

NASA RELATED CONFERENCES OR WORKSHOP ATTENDED

Workshops & Conferences Attended	Frequency Yes	Frequency No	Percent Yes	Percent No
NEWMAST/NEWEST	28	65	30.1	69.9
NSTA, NCTM, ITEA	25	68	26.9	73.1
State Workshops at Colleges	18	75	19.4	80.6
NSF Workshops	14	79	15.1	84.9
UCEP Workshops	4	89	4.3	95.7

Note: Respondents chose more than one answer when appropriate.

was conceived as the most effective method to make these materials available to the largest possible audience, many of whom do not have opportunities to attend conferences and workshops. It is also a continuing source of updated resources for conference and workshop participants after they have returned to their respective schools.

This question should be restructured to obtain more specific information about the percentages of teachers who have attended these workshops, and the number who have attended more than one. The survey data indicated that many of the Spacelink Educator Account holders had attended one or more NASA-related workshop. These teachers show by taking the initiative to attend extracurricular workshops and conferences, seeking additional resources on-line, and expanding their educations (question 20) that they are interested in growing personally and professionally, and see learning as a lifelong quest. Future research should include inquiries about exposure to aerospace education through other sources. In addition to those listed in this question, there are many other organizations who offer workshops and courses with aerospace connections. These include Young Astronauts, the Challenger Centers, U.S. Space Camp, the Astronaut Memorial Foundation, Civil Air Patrol, the U.S. Space Foundation, Operation Skyway, the Boy and Girl Scouts, and the Federal Aeronautics Administration.

It would also be useful to know how the educators became aware of the availability of the NASA Spacelink toll-free educator accounts. Spacelink Educator Accounts are introduced and distributed at the conferences and workshops mentioned in this question. Future research should seek to determine how many of the teachers who have been given toll-free account numbers have actually activated and used them, and also how the other teachers who are using toll-free accounts received them if not through the

above-mentioned conferences and workshops. This information would assist in planning future distribution practices and assessing the demand for the service.

Educators' Highest Level of Education

The highest level of education achieved by the respondents was: 37.6 percent had completed their bachelors degree, 52.6 percent had a masters degree, 2.2 percent had an Ed.S, 2.2 percent had an Ed.D, and 5.4 percent reported having earned a Ph.D. A summary of the data obtained in questionnaire item twenty is given in Table XX.

Over half the responding teachers have achieved masters degrees or greater, indicating the motivation to grow professionally and continue to learn. These teachers are demonstrating a desire to exceed the minimum requirements for certification and employment. Future research should examine the relationship between the use of Spacelink and other on-line resources and the interests, attitudes, and education level of teachers regarding professional development.

Comments

Several respondents included comments that were not attached to any particular question. Many of these appeared at the end of the survey:

- "Thanks for the opportunity for some input. I feel like there is so much more to this program than I am taking advantage of. Every time I access it I learn something new. But a manual would be very useful to those of us that have not had workshops available. Thanks."

TABLE XX

EDUCATORS' HIGHEST LEVEL OF EDUCATION

Educational Level	Frequency	Percent
Bachelor of Science (BS) or Bacheior of Arts (BA)	35	37.6
Master of Science (MS) or Master of Arts (MA)	49	52.6
Educational Specialist (Ed.S.)	2	2.2
Doctor of Education (Ed.D.)	2	2.2
Doctor of Philosophy (Ph.D.)	5	5.4
Totals	93	100.0

- "Aerospace activities have earned both my teaching partner and myself recognition on ABC TV's "Good Morning, America!", and The Presidential Award for Excellence in Elementary Science/Math Education. We are active aerospace educators and would like to work more intensively with NASA and OSU on aerospace curriculum development and education opportunities. Do not hesitate to contact me at this address if we can be of assistance."
- "Note: If more workshops becomes available I know more teachers will take advantage of it due to spacelinks [sic] availability at our school."
- "Good Luck on your survey. Spacelink is one of the best things that has happened to me as a teacher. You are from Oklahoma. . . I'm sure you are aware of how difficult it is for the rural community to get access. For my students and I, this is the only game in town. Keep up the good work."
- "I am a technology teacher and we communicate with tech. people at J.S.C. for research. I could not do what I currently do without my account."
- "I was part of Gerry Taylor's and Bob Fitzmaurice's summer program last year. I have used the appollo [sic] flight log materials, the Space Educator's Handbook Gemeni [sic] and Mercury activities. I have also helped bring Angelo Casaburi to our district for one of his wonderful activities. I still need to use the dial up services because my lab is in a trailor [sic] and is not hooked up to the internet that the rest of the building will be. I am working on some wayy [sic] to afford some other acess [sic] so I can go to the other activities and use the graphic activities. I am also a building rep. for teaching the internet [sic] to the Navajo Nation in conjunction with Los Alomas [sic]

Labs. (sorry about the spelling errors). Please contact me if I can do anything more to spread this wonderful service. I hope to be one of the teachers who returns to Houston this summer to help train more new STEP teachers, too. Thanks for this opportunity again."

- "I hope this helps you, there are so many areas on the Spacelink that I haven't taken the time to explore. I am in Scottsboro, AL if there is EVER an opportunity to take a course in Huntsville, or via this way, I'll take the course."
- "Question num.5 I cant [sic] download yet, Im [sic] in need of a printer. Im [sic] still working on the many uses this link has to offer. Wish I had more oportunities [sic] to learn more about this technology to be of more help to my students and fellow teachers. Thanks to you. Your friend in P.R.[Puerto Rico]"
- [yes, I've been trained in staff development to use on-line resources] "However, each system is so different that I've found the only way to really learn is by doing."
- "Our principal is quite knowledgeable about this technology and is our main contact person. But, he has many duties and other issues that must often take priority."
- "teachers have access to our building 24 hours a day."
- "Because of our unique school district--many one and two teacher schools--we have a three year rotating science curriculum. Although we incorporate all the sciences every year, we do in-depth studies of scientific fields every

three years. Our aerospace unit does not come around until the 1997-98 school year. However, because of my interest in space, my students get a fairly good dose of it every year."

Research Questions

Concern has been expressed by the NASA Aerospace Education Specialists, who train teachers to use Spacelink, that because of limited access to hardware, software, and technical support, teachers may not be enjoying the full array of services offered by the on-line resource . Keeping in mind the original purpose and objectives of Spacelink and AESP, program administrators wish to determine whether those objectives are being met. It is important to have ongoing assessment and evaluation to show the effectiveness and impact of Spacelink, to justify continued support from NASA. The following research questions evolved from these concerns and from the review of literature.

Research Question Number One

Describe the use of NASA Spacelink by holders of Spacelink Educator Accounts in terms of access: availability of technology, frequency of use, duration of connection, and services utilized. To obtain supporting data for this question, the following survey items were used (the question numbers refer to the numbers of the corresponding survey questions):

2. How many times per week do you log on to Spacelink?
3. How long is your average Spacelink connection?
4. Which Spacelink services have you used?

5. How many times have you downloaded a file from Spacelink?

6. Do you have access to Spacelink in your school?

   If yes, where is the computer located?

8. How many computers are available for use in your classroom?

12. Do students in your class(es) use Spacelink?

    If yes, what services do they use?

13. How many hours is your school open after regular school hours and on weekends to maximize the availability of computer equipment for teachers, students and the community?

The evidence indicates that the overwhelming majority, over 88 percent, of Spacelink use by holders of Spacelink Educator Accounts is made possible by the use of the toll-free number (Table I). If the toll-free number was not available, the usage of Spacelink would probably suffer a sharp decline. Most Spacelink users log on to Spacelink four or more times per week. Over one third (nearly 37 percent) of the users log on to Spacelink for 10 or more hours per week (Table II).

Over one half (52 percent) of the Spacelink users spend from 10 to 29 minutes per connection logged on to Spacelink. About one third spend from seven to ten minutes logged on, and almost ten percent spend over an hour per connection.

Seventy-one percent of the educators have access to Spacelink in their schools, but less than one third of them have computers in their classrooms. Ten percent have computers in the main school office, one third have access to computers in their library or media center, and 14 percent have computer laboratories. Seventeen percent said their computers were in other locations, such as other teachers' classrooms.

Half the respondents said they had between one and five computers in their classrooms, although 68 percent said earlier they did not have computers in their classroom. This discrepancy may have been caused by confusion as to whether they interpreted the question to mean computers with Spacelink capabilities, or all types of computers. Nearly ten percent said they had ten or more computers in their classroom. Nearly 15 percent said they had none.

Less than half of the regular users spend more than 30 minutes per session logged on to Spacelink. Considering that all of them use E-mail, not many of the users are spending enough time logged on during an average Spacelink session to do any serious research. Their time on-line is restricted by scheduling constraints and by lack of connectivity. Well over half the Spacelink Educator Account holders log on an average of at least once a day. This daily usage shows knowledge of the system if they are able to get logged on, get what they need, and get back out in a short amount of time.

The features educators use most appear to be E-mail, the Internet, and bulletin boards. These are the most interactive of the features offered, indicating that the teachers are using the connection to share ideas with other teachers and enhance their teaching skills. Their regularity of use shows a commitment to the system and to their profession. It also is evidence that NASA is making a valuable contribution to educators by offering them the opportunity to get connected to the Internet where they otherwise would not be, and also by providing them aerospace resources. These resources may appear to be of secondary importance to the connectivity itself; however, as availability of hardware, software, and connectivity improve the regular habit of Spacelink use will bring teachers

to explore more deeply the many offerings in aerospace, science, mathematics, and technology.

The noticeable tendency to the extremes on the question regarding downloading was probably because people who know how to download do it frequently, but downloading is a skill which many people still have not acquired. Seven respondents expressed frustration and disappointment at not being able to download software or files using the PINE™ program, and there were comments about the text-only Telnet system.

Less than one third of the teachers have computers in their classrooms with Spacelink access. In question eight, we see that nearly fifteen percent have no computers at all. Schools still have so few computers that they are placing them in a central location such as the library, media center, or a computer laboratory to facilitate equitable availability to the entire school population. This limits spontaneous usage of computers for research, writing, and extra projects by teachers and by students. In question twelve we see that less than half the respondents have students using Spacelink. The location of the computers could be a factor in this case. Only about 35 percent of the schools have enough computers in the classrooms where teachers and students can access Spacelink or the Internet as easily as they could refer to a reference book; using the media center or computer lab often involves advance scheduling and logistical problems. Computer use in classrooms is far from prevalent at the present time. Possession of the hardware does not ensure its effective implementation.

Of over 1500 Spacelink Educator Account holders, only 96 logged on for twenty-five hours or more as of January, 1996. This is under six percent. And of those, nearly 90 percent were using the toll-free access number.

In their comments, teachers reported student involvement in special projects and programs on-line. "We participated in 'Jupiter On-line' as much as we could. We don't have satellite connections to actually view the NASA stations or view astronauts when they are in space. We also sent questions to 'MARSLINK,' but they were never answered. My students were disappointed. Several NASA specialists, however, tried to answer their questions when we just happened to find them on a conference line one morning."

The low percentages of student usage could be related to the low number of computers, or to the locations of the computers in the schools. Until computers are located in the classrooms where students may feel comfortable turning to them spontaneously to use as a resource or reference without having to make prior arrangements or moving to another physical location, the percentage of student use will not rise

Schools have a great potential to be used as a place for research and discovery. It is unfortunate that these facilities are limited in their usefulness because of the restricted operating hours. This problem has been recognized and remedied in some communities. Many schools are converting to a year-round operating schedule. Some are offering adult classes and computer training at night, on weekends, and in the summer. Initiating programs like these calls for additional staffing and security, but the benefits are considerable. Using the facilities and the costly computer equipment instead of letting them stand idle is more cost-effective, and offers the potential to increase the earning potential and self esteem of under-educated adults in the community as well as the students and teachers in the school.

Research Question Number Two

Describe the financial, technical, and staff development support for Spacelink use. To obtain supporting data for this question, the following survey questions were used (the question numbers refer to the numbers of the corresponding survey questions):

1. How do you access your Spacelink Educator Account?
7. How is the cost for your access to Spacelink paid?
9. Have you been trained in staff development to use on-line resources?
10. Does your school or school system have a computer contact person or expert whose main responsibility is staff development?
11. Does your school or school system have a computer contact person or expert whose main responsibility is technical support?

The vast majority of the registered users of Spacelink Educator Accounts who had logged on for 25 or more hours as of January, 1996, did so using the NASA-provided toll-free accounts. Almost 11 percent used either a direct dial modem, a university system, or local service providers. Only about one percent used commercial servers. These figures may reflect the financial resources of American educators and suggest that although they are anxious to avail themselves of the latest electronic resources, they may not be inclined to pay for them. This may be particularly true when the expensive on-line time is being used for researching resources to be used in the classroom for professional purposes. The toll-free accounts should not be discontinued until there is some other provision made for educators to have low- or no-cost access to the Internet.

Responses to question one indicated that 88.3 percent of the respondents access Spacelink through the toll-free account. But question 7 revealed that 95.7 percent used the toll-free account. This discrepancy may have resulted from confusion in interpreting the questions. The responses to this question show a correlation with the responses to research question one. Educators are not inclined to spend personal funds on connectivity to the Information Highway.

Support for use of Spacelink includes provision for staff development. Just under half of the respondents reported having been trained to use on-line resources in staff development sessions. About half of the educators reported having a computer contact person available in their school to provide staff development, answer questions as they arise, and assist in using on-line resources. A higher number (63 percent) said they had a computer contact person on hand in their school to keep the hardware in working order, and help the teachers and staff with technical problems. A larger number of teachers have not received training in staff development sessions for using on-line resources than the number who have. This could be related to the lack of hardware, software, Internet connectivity, and money. Teacher training needs to be increased dramatically. Over half the respondents are aware that there is a person on their staff who is knowledgeable about computers and whose responsibility it is to impart that knowledge to the rest of the school staff.

Schools are more adequately staffed with technicians than with facilitators. Teachers seem to feel that it is easier get their hardware serviced when necessary than it is to get assistance in learning to use it. It would be useful to learn whether those teachers who do not have local technical assistance feel that they are inconvenienced by this lack of

support. Training and technical support go hand in hand; neither is abundant at the present time.

Research Question Number Three

Describe teacher and student use of Spacelink's Aerospace curriculum support: Teacher Guides, files, images, and software downloaded.

To obtain supporting data for this question, the responses from the following survey items were used (the question numbers refer to the numbers of the corresponding survey questions):

4. Check the Spacelink services which you have used:

   ___Aerospace Education Teacher Guides

   ___Software

   ___Images

5. How many times have you downloaded a file from Spacelink?

12. Do students in your class(es) use Spacelink? If yes, do they access:

   ___Aerospace Education Teacher Guides

   ___Software

   ___Images

14. Is Aerospace Education a formal part of your curriculum?

15. Before you had access to Spacelink, did you use Aerospace activities in your teaching?

16. How has your use of Aerospace activities in your teaching been influenced as a result of your use of Spacelink?

17. How many aerospace activities have you added to your lesson plans as a result of your Spacelink use?
18. Which of the four major NASA Teacher Guides have you accessed through Spacelink?

Over half the educators reported having accessed one or more of the NASA Teacher Guides: the Rockets guide, Suited for Spacewalking, Microgravity, or Space Based Astronomy. Software has been downloaded from Spacelink by 43.6 percent. Only 27.7 percent said they have viewed images. This may reflect the fact that the toll-free accounts are accessed by Telnet, which is a text-based system. In order to view images teachers must download them, go off-line, and open the files using graphics software, and then view the images on the monitor or print them using a color printer. The survey did not include questions about the availability of this type of software, or a color printer. However, many of the survey responses revealed that the teachers were having problems downloading from Spacelink. Graphics software is available on Spacelink for downloading, but the teachers may not be aware of this, or do not know how to download it or how to use it when they get it. The noticeable tendency to the extremes on the downloading question was probably because people who know how to download do it frequently, but downloading is a skill which many people still have not acquired. Seven respondents expressed frustration and disappointment at not being able to download software or files using the PINE™ protocol, and there were comments about the text-only Telnet system.

Nearly half the responses indicated that students use Spacelink. Of those, only 7.5 percent reported that students had accessed NASA Teacher Guides. This is to be

expected, since the Teacher Guides are clearly composed of background science information and lesson plans. Students are more likely to be interested in images, "hot topics," and recent news releases from NASA. Many students are more knowledgeable than their teachers about computer use. The teachers could take advantage of this expertise and enlist students' help in learning to use on-line features.

Considering the length of time for Spacelink sessions reported in question two, the data indicates that most of the time on-line is spent reading and writing E-mail. The next most frequently used service is the Internet. It is apparent from their responses that some of the frequent Spacelink users are using the toll-free number as a way to access the other information available on the Internet and may not be using the service to enhance their use of Spacelink-provided aerospace activities and information in the classroom.

In their comments, teachers reported student involvement in special projects and programs on-line. "We participated in 'Jupiter On-line' as much as we could. We don't have satellite connections to actually view the NASA stations or view astronauts when they are in space. We also sent questions to 'MARSLINK,' but they were never answered. My students were disappointed. Several NASA specialists, however, tried to answer their questions when we just happened to find them on a conference line one morning."

The low percentages of student and teacher usage could be related to the low number of computers, or to the locations of the computers in the schools. Until computers are located in the classrooms where students may feel comfortable using them spontaneously as a resource or reference without having to make prior arrangements or moving to another physical location, the percentage of student use will not rise.

Additional research should be done to learn more about usage patterns of all Spacelink users; this research should not be limited to users of Spacelink Educator Accounts.

One of the goals of the Aerospace Education Services Program (AESP) is to help teachers learn to use aerospace activities as an avenue to assist in integrating the curriculum. The evidence indicates a need for an increased emphasis on how to use aerospace to teach all subjects. Less than ten percent of the schools teach aerospace as a separate subject. The responses indicated very few schools where aerospace is considered a part of more than one area of the curriculum. One fourth of the respondents said aerospace is not a part of their curriculum at all. This indicates the teachers are not aware of the connections between aerospace and the principles of physics, mathematics, biology, geometry, and many other curriculum areas.

The responses to research question three demonstrate a need for introduction of aerospace activities to teachers as a vehicle for teaching existing curricula. Teachers are wary of "yet another added responsibility on their already overloaded calendar." They are more interested when they can be shown how to use Aerospace as a way to make their jobs easier. The high percentage of respondents who answered that this question concerning the use of aerospace activities was not applicable to them may reflect a lack of awareness about the science, math, and technology applications in the field of aerospace.

Responses to question 16 indicated that two thirds of the teachers reported that their use of aerospace activities in the classroom has either remained the same or increased since they have had access to Spacelink. Over half reported an increase. Of the teachers who did not use aerospace activities before, 19 of 28 (67.9 percent) now do, after accessing Spacelink. Of the 44 teachers who were already using aerospace activities in

their curriculum, 32 (72.7 percent) have increased that use. This evidence indicates that Spacelink is providing a useful service and is meeting the goals and objectives of Spacelink, of the NASA Education Division, and the agency itself.

Over half the teachers report having added aerospace lessons to their repertoire of teaching plans as a result of their access to Spacelink. This information attests to the fact that Spacelink is effective in its task of disseminating NASA resources to the education community. However, the high number of "not applicable" responses implies that these teachers are not aware of the many possibilities of using aerospace activities to integrate the curricula in a variety of disciplines.

If not for the problems reported earlier with the downloading process, the number of Teacher Guides downloaded would probably have been higher. Also, the "text-only" version of these guides does not capture the essence of their quality or their usefulness.

Research Question Number Four

Determine whether Spacelink use by teachers is related to their exposure to NASA -related conferences and workshops on aerospace education.

In order to answer this research question, the following survey item was used (the question number refers to the number of the corresponding survey question):

19. Which of the following conferences or workshops have you attended?: (mark all that apply)

__NASA NEWMAST or NEWEST workshop

__National Conference of NSTA, NCTM, or ITEA

__State Aerospace Education Workshops held at colleges

__National Science Foundation workshops

__Urban Community Enrichment Program Summer Workshop.

Past research has indicated a strong interest among workshop and conference participants in NASA materials and publications for teachers (Marks, 1975). Spacelink was conceived as the most effective method to make these materials available to the largest possible audience, many of whom do not have opportunities to attend conferences and workshops. It is also a continuing source of updated resources for conference and workshop participants after they have returned to their respective schools.

The data indicates that many of the Spacelink Educator Account holders are attending these conferences and workshops. Future research should include inquiries about exposure to aerospace education through other sources. In addition to those listed in this question, there are many other organizations who offer workshops and courses with aerospace connections; these include Young Astronauts, the Challenger Centers, U.S. Space Camp, the Astronaut Memorial Foundation, Civil Air Patrol, the U.S. Space Foundation, Operation Skyway, the Boy and Girl Scouts, and the Federal Aeronautics Administration.

This question should be restructured to obtain more specific information about the percentages of teachers who have attended these workshops, and the number who have attended more than one.

Research Question Number Five

Describe the education level of the teachers who are using Spacelink Educator Accounts.

In order to answer this question, the following survey item was used (the question number refers to the number of the corresponding survey question):

20. What is the highest level of education you have achieved?

Over half the responding teachers have achieved masters degrees or greater, indicating the motivation to grow professionally and continue to learn. These teachers are demonstrating a desire to exceed the minimum requirements for certification and employment.

Summary

This chapter has consisted of a presentation of the findings from the Survey on Spacelink Educator Use and from the research questions resulting from the review of literature. Data obtained from the questionnaire have been discussed and analyzed. The data have been presented in two sections.

The first section contained responses and analyses for the questionnaire items. The frequencies and percentages in that section were concerned with the individual questions from the survey. The second section contained answers to the research questions as derived from the analysis of the questionnaire responses.

The following chapter, Chapter V, will present the conclusions and recommendations which resulted from the research on educator use of Spacelink.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

The purpose of this study was to acquire information that can be used to evaluate the effective use of NASA Spacelink, an on-line education resource, by teachers. Information was gathered to determine:

How teachers access their accounts (toll-free number, commercial server, or direct dial-up connection);

- How often and for how long teachers log on to Spacelink;
- Which services provided by Spacelink are used most often;
- Whether teachers are downloading files, lesson plans, Teacher Guides, and software from Spacelink for use in their classrooms;
- What kind of hardware, software, and technical support is available in schools
- Whether students are using Spacelink at school;
- Whether Aerospace was part of the curriculum before the teachers had access to the NASA on-line resource;
- Whether access to Spacelink has influenced teachers' use of Aerospace activities in the classroom;

- Whether any correlation exists between Spacelink users and alumnae of various NASA Aerospace Education workshops;
- The highest level of education achieved by frequent Spacelink users.

The subjects of this study were educators who are registered users of Spacelink Educator Accounts and had logged on to Spacelink for 25 hours or more as of January, 1996. Names and E-mail addresses of these selected Spacelink users were compiled at the office of the Spacelink Administrator at the NASA George C. Marshall Space Flight Center in Huntsville, Alabama. A total of 96 educators were used in this study.

The Survey on NASA Spacelink Educator Use was designed to collect data on the use of NASA Spacelink by holders of Spacelink Educator Accounts in terms of the availability of technology, frequency of use, duration of connection, and services utilized. The study examined the financial, technical, and staff development support for Spacelink use. The respondents reported their usage of Spacelink's Aerospace curriculum support materials and resources, Teacher Guides, files, images, and software downloaded. The research sought to determine whether Spacelink use by teachers is related to their exposure to NASA-related conferences and aerospace education workshops. The study reported the education level of Spacelink Educator Account holders.

The approved questionnaire was comprised of 20 questions. The questionnaire, accompanied by a letter of explanation, was sent to the participants by E-mail on Spacelink on or after January 13, 1996. A total of 94 participants returned surveys that were suitable for data interpretation. The participants returned the questionnaires by way of E-mail on Spacelink.

Upon receipt of the questionnaire, the data were coded and entered into a Microsoft Excel spreadsheet which was then transferred to STATPAK for statistical analysis. Frequency counts were tabulated for each question and percentages were computed for the total returned questionnaire population.

Conclusions

Based on the findings of the study, evidence supports the following conclusions: The majority of the educators who are registered for Spacelink Educator Accounts and have logged on to the on-line resource for twenty-five hours or more are using the toll-free number provided by NASA. The resource would not be used as much by teachers if the toll-free number was not available.

The majority of the respondents are logging on to the system four or more times a week; over one third are logging on ten or more times a week.

Over half of the educators who answered the survey are logging on for periods of between 10 and 29 minutes each time. Only about 10 percent are logging on for one hour or longer each time. Considering that 100 percent of these users are using E-mail, the amount of time logged on indicates that very little research is being accomplished. All of the educators who responded to the questionnaire are using E-mail. The Internet was the second most popular service, with 83 percent of the respondents using it. About 70 percent of the teachers reported using newsgroups. The most used features of Spacelink are not those which deal directly with aerospace activities and curriculum for the classroom. The most popular features are interactive ones. More training and more effort

to publicize the services would encourage the educators to take advantage of the other features.

Only about 27 percent of the participants had downloaded software and information from Spacelink. Based on the comments included on the questionnaires, this low usage is attributable to the lack of training and the difficulty involved in downloading. Because the Spacelink toll-free number uses Telnet, which is a text-based protocol, users are not able to view images on-line. Instead, they must download the image, convert it to graphics using the appropriate type of software, and open it off-line to view or print. The reported confusion, frustration, and difficulty of the downloading process may have affected the number of respondents who used images and downloaded information. This problem could be remedied by providing point-to-point protocol (PPP) for the toll-free accounts which support Netscape and other browsers for the World Wide Web, or by providing training for the account holders in downloading using the present system.

In relation to the accessibility of Spacelink in schools, 71 percent of the educators reported that they did have access at school. The respondents, however, noted that just under 31 percent have computers in their classrooms that are equipped for connecting to Spacelink, and about 33 percent have them in their media centers or libraries. Almost 17 percent said they had access to computers at other places in the school, such as the faculty lounge, other teachers' classrooms, the gifted and talented classroom, their personal offices, and the district office. Over 14 percent have computer laboratories in their schools, and just over 10 percent have computers in their main school offices. The more convenient the computers are, the more likely it is that the teachers will use them as a

professional resource. As more and more classrooms become connected, the use by teachers and students will increase.

Over 70 percent of the respondents have one or more computers in their classrooms, but only 31 percent of the respondents can access Spacelink in their classrooms. Almost 10 percent have 10 or more computers in their classrooms, but almost 15 percent have none. The data indicates there are wide variations in the numbers of computers in schools across the country. Accessibility to on-line resources is not yet a common occurrence in schools. The Spacelink Educator Accounts remain a valuable resource to teachers who have no other source of connectivity.

Almost half of the teachers said they had been trained for using on-line resources in staff development. Since only 31 percent of the teachers have access to Spacelink in their classrooms, the majority of the teachers are not able to practice what they have learned in training. Training reflects an optimistic assumption that connectivity is forthcoming, but training without practice by using new knowledge daily is often useless.

About 50 percent of the teachers have a contact person in their schools who is knowledgeable about computers and provides staff development. Ideally every school should have such a person; eventually all teachers should be very knowledgeable about computers. Almost 63 percent of the educators have a contact person in their schools who provides technical assistance with computers. More schools have technicians than trainers. A large number of computers are useless if no one knows what to do with them.

Nearly 43 percent of the educators are able to provide students with access to Spacelink. Of these students, nearly 75 percent of them use E-mail, and 60 percent have accessed the Internet through Spacelink. Over 33 percent have used "hot topics," 33

percent have used NASA press releases, 25 percent have used bulletin boards, over 25 percent have used images from Spacelink, 15 percent have downloaded software, and 14 percent have computer laboratories in their schools. About 15 percent use the conferencing feature and less than 10 percent of the students have accessed NASA Teacher Guides, which is to be expected, since these features were intended primarily for teacher use only. About 17 percent of the respondents reported that their students have used other services through their Spacelink accounts. Students may access the Spacelink Public Library for most of the information they need. The Spacelink Educator Accounts provide services specifically designed for teachers, including the ability to network with other educators. When schools acquire connectivity to the Internet, students will be able to use the Spacelink Public Library without depending on their teachers toll-free NASA accounts.

In response to the inquiry about the availability of computers to students, teachers, and interested members of the community after school hours and weekends, 33 percent of the schools are not open after school hours, and over 84 percent of the schools are not open on weekends. About 15 percent of the schools are open one hour after school on weekdays; about 15 percent of schools are open two hours, and about 13 percent are open four or more hours daily. About 10 percent of the schools are open for four or more hours on the weekend. A much more practical and cost effective use of the school facilities and resources would be accomplished by establishing a year-round school schedule and longer hours on weekdays and weekends. This would require additional staffing and security, but may provide benefits which would exceed the expense.

About 70 percent of the educators reported that Aerospace Education is part of their curriculum. Over 50 percent of those include aerospace in their Science classes. Two

percent teach aerospace in Math classes, nine percent teach it as a separate subject, and 11 percent teach aerospace in some other context. Since about 70 percent of the teachers now use aerospace activities whereas only half the teachers said they had used aerospace activities in their classrooms before they had Spacelink access, there has been a 20 percent increase in use of aerospace activities attributable to Spacelink use.

Of the teachers who did not use aerospace activities before, 19 of 28 (67.9 percent) now do, after accessing Spacelink. Of the 44 teachers who were already using aerospace activities in their curriculum, 32 of them (72.7 percent) have increased that use. This evidence indicates that Spacelink is providing a useful service and is meeting the goals and objectives of Spacelink, of the NASA Education Division, and the agency itself.

Over half the teachers have added Aerospace activities to their lesson plans. One fourth of those have added from one to four activities; one tenth have added from five to nine activities, and one fourth have added ten or more. Spacelink is accomplishing its purpose of disseminating NASA resources to educators.

The Rocket Guide has been the most popular Teacher Guide to be accessed through Spacelink. Almost 40 percent have used it. Over 23 percent have accessed Space Based Astronomy; more than 19 percent have used the Microgravity Guide; and over 22 percent have accessed Suited for Spacewalking. These numbers will probably increase as more and more schools are wired for the Internet and have the capability to view and download graphics files.

About 30 percent of the teachers who have used their Spacelink Educator Accounts more than 25 hours have attended a NASA NEWMAST or NEWEST workshop. About 27 percent have attended a national conference of a professional

education organization: the National Science Teachers Association (NSTA), the National Council of Teachers of Mathematics (NCTM), or the International Technology Education Association (ITEA). Over 19 percent have participated in a State Aerospace Education Workshop held at a college. About 15 percent have attended a National Science Foundation (NSF) workshop, and four percent have attended a NASA Urban Community Enrichment Program (UCEP) summer workshop. Past research has indicated a strong interest among workshop and conference participants in NASA materials and publications for teachers (Marks, 1975). Spacelink was conceived as the most effective method to make these materials available to the largest possible audience, many of whom do not have opportunities to attend conferences and workshops. It is also a continuing source of updated resources for conference and workshop participants after they have returned to their respective schools.

Over 37 percent of the Spacelink users surveyed have bachelors degrees. Over half have Masters Degrees. Over four percent have Education Specialist degrees or Doctorates in Education. Over five percent have Ph. D degrees. The teachers with Doctorate degrees were not the ones who reported accessing the most NASA materials and aerospace activities for use in the classroom. They were the ones who most often answered that the questions were not applicable, because they were not in classroom situations. The majority of the respondents hold bachelors or masters degrees and have not yet reached the terminal degree level, and by the very nature of their profession are consummate lifelong learners. These teachers are the intended audience of Spacelink.

In conclusion, the toll-free accounts were designed as a stop-gap measure to provide access to NASA Spacelink on-line resources for educators who had no other

method of accessing the service. It was hoped that as the Internet became more accessible and reasonably priced, and more schools became connected, teachers would find that the various Internet browsers with their graphic capabilities and simplified features more user-friendly and would no longer need and use the toll-free access. It is apparent from this study that time has not yet arrived. Future studies will determine whether it ever does, or whether the assumption was erroneous. Out of over 1,500 registered Educator Account holders, there were only 96 in January, 1996, who had spent 25 hours or more logged on to Spacelink. Some registered but never logged on again. Further research on the Educator Account holders could provide interesting insights into user needs.

Recommendations

Whereas this study has set the precedent for research on Spacelink usage, the research should be continued and expanded in the future. Additional research is necessary to gain a more complete understanding into how Spacelink serves the needs of different populations of educators as technology changes and the amount of teacher access changes.

In regard to Spacelink features used, the following recommendations are made:

Teachers need to be better trained in how to download files, software, and images. The on-line Help feature should be expanded and simplified to assist teachers who do not have the opportunity to attend workshops on Spacelink.

The toll-free number should be a point-to-point protocol access so that teachers could use Netscape or other Internet browsers to explore the World Wide Web. This

would solve the downloading problem and facilitate access to images and certain GIF files. It would be particularly helpful to teachers in rural communities where low-cost Internet access will not be available as quickly as it will be in urban areas.

NASA should contribute funding and volunteer expertise to movements like NetDay to expedite the process of connecting and networking schools to the Internet, thereby increasing access to Spacelink.

Spacelink should be more proactive in encouraging teachers in all disciplines to use aerospace activities as vehicles for integrating curriculum and motivating the students to study science, mathematics, and technology.

Spacelink should actively publicize the Stephenson-Wydler Act, which mandates that excess government equipment (including computers) be made available to educational institutions at little or no cost.

In addition to mail, E-mail, and long distance access to Help via the Spacelink Administrator, Spacelink should have a toll-free tech-support line available for educators to make it easier for new users to ask questions and experience successful connections.

Workshops on Spacelink usage should be conducted more often and be more widely publicized so that more educators will be aware of the services offered and learn to use the features.

In answering the research questions for this study, the researcher was inspired to suggest future research to answer still other questions regarding the use of Spacelink by educators. Recommendations for further research are found in Appendix E. These recommendations will guide future researchers in learning more about the usage patterns

of Spacelink Educator Account holders and the effectiveness of Spacelink as a resource for teachers.

Summary

This study provides information that assists in evaluating the effective use of Spacelink by educators. It established the historical background for electronic educational resources, provided an overview of the resources available through Spacelink, and surveyed a sample of teachers who have registered to use Spacelink as to their usage patterns and resultant teaching methods. The survey data provided a measurement of the effectiveness of educators' use of Spacelink as a teacher resource. Recommendations for improving teachers' effective use of Spacelink were made and topics for further evaluations were suggested. The data captured in this study and suggestions for further improvements and evaluations of NASA Spacelink offer ways to better serve the needs of teacher users.

This study was the first of its kind. During the time this research was being conducted, relevant new literature was published daily, in print and electronically. NASA has been a national leader in providing Internet resources in science, mathematics, technology, and education. The information infrastructure is growing much more rapidly than the ability of educators to gain access to it. The people who are so eager to build the information infrastructure of the future must remember who will be using it in the future.

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APPENDIXES

APPENDIX A

PARTICIPANT QUESTIONNAIRE

Dear Spacelink Educator Account User:

NASA is continually striving to improve the services available to you on Spacelink. It is our hope that you are finding resources and activities on Spacelink that are helpful to you in your teaching. So that we may serve you better, we are asking you to take a few moments to answer the questions on the survey below.

This survey has been sent to you by e-mail. Perhaps you have not logged in lately, and you may not have seen it. You may mark this survey and return it in the enclosed self-addressed, stamped envelope, or you may log on to Spacelink and respond electronically. Please do not feel that you are not important to our survey because you are not a classroom teacher, or the questions do not really apply to you. We have received a 93% response and are anxious to make it 100%, so please respond even if itÕs to say that you never use your account. That is an important piece of information for us. If a question does not apply you may mark NA, or insert a comment. Every response is important in our research. Although we have sent it twice before, we are resending it today in case you did not get the others, or lost them in cyberspace. If you have trouble moving through the questions with the arrow keys, you may send the answers in list form. We really appreciate your help. Your time and effort will contribute to improvements on Spacelink. Thank you.

NOTE: This letter was transmitted electronically on Spacelink E-mail. It was preceded on-line by a header which included the date, time, senders' E-mail address, and server identity.

Oklahoma State University
Aerospace Education Services Program
Department of Aviation and Space Education
Contractor - National Aeronautics and Space Administration

To respond to the survey, please follow these directions:
Press R (for reply).

When you see a prompt asking if you want to include the original message in your reply, respond by pressing Y.

Then use the arrow keys to move through the questions.
Mark your responses with an X.

Then press CTRL - X to send.

Thank you very much for your help.

SURVEY ON NASA SPACELINK EDUCATOR USE

1. How do you access your Spacelink Educator Account? (mark the one you use most often)

__ Toll-free number
__ Commercial server (i.e. AOL, Prodigy, Compuserve)
__ Direct dial-up Internet connection
__ Other_____

2. How many times per week do you log on to Spacelink?

__1 - 3 __4 - 6 __7 - 9 __10 or more

3. How long is your average Spacelink connection?

__ less than 10 minutes
__ 10 - 29 minutes
__ 30 - 59 minutes
__ 1 hour or longer

4. Check the Spacelink services which you have used: (mark all that apply)

__ E-mail
__ Conferencing
__ Bulletin Boards
__ Newsgroups
__ Hot Topics
__ Aerospace Education Teacher Guides
__ NASA Press Releases
__ Software download
__ Images
__ the Internet
__ Others_____

5. How many times have you downloaded a file from Spacelink?

__0 __1 - 3 __4 - 6 __7 - 9 __10 or more

6. Do you have access to Spacelink in your school?

__ Yes __ No __NA

If yes, where is the computer located?

__ Your classroom
__ Main Office
__ Library or Media Center
__ Computer Lab
__ Other_____

7. How is the cost for your access to Spacelink paid? (mark only one)

__ Toll Free Educator Account
__ School System
__ State
__ Personal
__ Other_____

8. How many computers are available for use in your classroom?

__0 __1 __2 - 5 __6 - 9 __10 or more __NA

9. Have you been trained in staff development to use online resources?

__ Yes __ No

10. Does your school or school system have a computer contact person or expert whose main responsibility is staff development?

__ Yes __ No __ I do not know __NA

11. Does your school or school system have a computer contact person or expert whose main responsibility is technical support?

__ Yes __ No __ I do not know __NA

12. Do students in your class(es) use Spacelink?

__ Yes __ No __NA

If yes, what services do they use?

__ E-mail
__ Conferencing
__ Bulletin Boards
__ Newsgroups
__ Hot Topics
__ Aerospace Education Teacher Guides
__ NASA Press Releases
__ Software download
__ Images
__ the Internet
__ Others_____

13. How many hours is your school open after hours to maximize the availability of computer equipment for teachers, students and the community?

Weekdays	Weekends
__0 hours	__0 hours
__1 hour	__1 hour
__2 hours	__2 hours
__3 hours	__3 hours
__4 or more hours	__4 or more hours
__ NA	

14. Is Aerospace Education a formal part of your curriculum?

__ No
__ Yes, as a separate subject
__ Yes, as part of the Science curriculum
__ Yes, as a part of the Math curriculum
__ Other _____
__ NA

15. Before you had access to Spacelink, did you use Aerospace activities in your teaching?
__ Yes __ No __NA

16. How has your use of Aerospace activities in your teaching been influenced as a result of your use of Spacelink?
__ I did not use them before, and I still do not.
__ I did not use them before, but now I do.
__ I did not use them before but now I use them often.
__ I used them before, but now I use them less.
__ I used them before, and now I use them the same amount.
__ I used them before, but now I use them more.
__ I used them before, and now I use them much more.
__ NA

17. How many aerospace activities have you added to your lesson plans as a result of your Spacelink use?
__ 0 __ 1 - 4 __ 5 - 9 __10 or more __ NA

18. Which of the four major NASA Teacher Guides have you accessed through Spacelink? (mark all that apply)
__ Rockets
__ Space Based Astronomy
__ Microgravity
__ Suited for Spacewalking

19.Which of the following conferences or workshops have you attended?: (mark all that apply)
__NASA NEWMAST or NEWEST workshop
__National Conference of NSTA, NCTM, or ITEA
__State Aerospace Education Workshops held at colleges
__National Science Foundation workshops
__Urban Community Enrichment Program Summer Workshop

20. What is the highest level of education you have achieved?
__B.S. or B.A.
__M.S. or M.A.
__Ed S
__Ed D
__Ph D

The END. Thank you.

APPENDIX B

INSTITUTIONAL REVIEW BOARD

APPROVAL FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 02-07-96 **IRB#:** ED-96-072

Proposal Title: USE OF AEROSPACE ACTIVITIES IN THE ELEMENTARY CLASSROOM BY TEACHERS WHO HAVE ACCESS TO NASA'S SPACELINK

Principal Investigator(s): Steven K. Marks, Ellen Hardwick

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature:  Date: February 9, 1996

Chair of Institutional Review Board

APPENDIX C

COVER LETTER TO PARTICIPANTS

February 19, 1996

Oklahoma State University
Aerospace Education Services Program
Department of Aviation and Space Education
Contractor - National Aeronautics and Space Administration

Dear NASA Spacelink User,

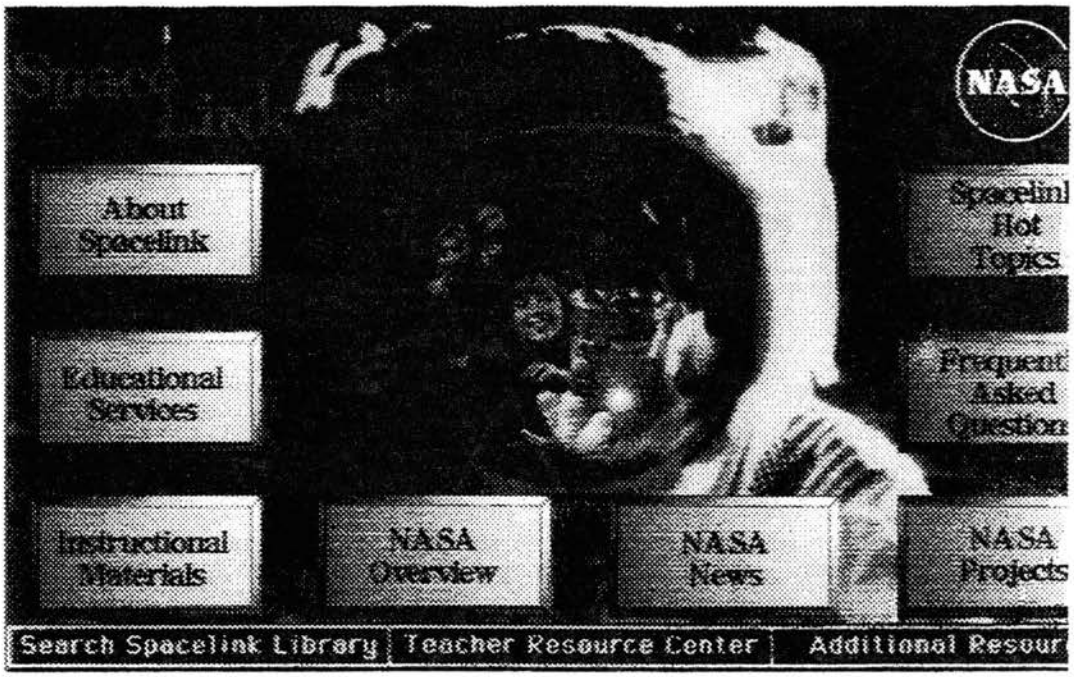
NASA is continually striving to improve the services available to you on Spacelink. It is our hope that you are finding resources and activities on Spacelink that are helpful to you in your teaching. So that we may serve you better, we are asking you to take a few moments to answer the questions on the survey below. To respond to the survey, please follow these directions:

1. Press R (for reply).
2. When you see a prompt asking if you want to include the original message in your reply, respond by pressing Y.
3. Then use the arrow keys to move through the questions.
4. Mark your responses with an X.
5. Then press CTRL-X to send.

Thank you very much for your help.

APPENDIX D

SPACELINK INTERNET HOME PAGE



NASA Spacelink
An Aeronautics & Space Resource for Educators

- Spacelink Public Electronic Library:
  - About Spacelink
  - Educational Services
  - Instructional Materials
  - NASA News
  - NASA Overview
  - NASA Projects
  - Spacelink Frequently Asked Questions
  - Spacelink Hot Topics
  - Keyword Search the Spacelink Library
- Spacelink Teacher Resource Center
- Additional Resources

NASA Home Page Search the Spacelink Library

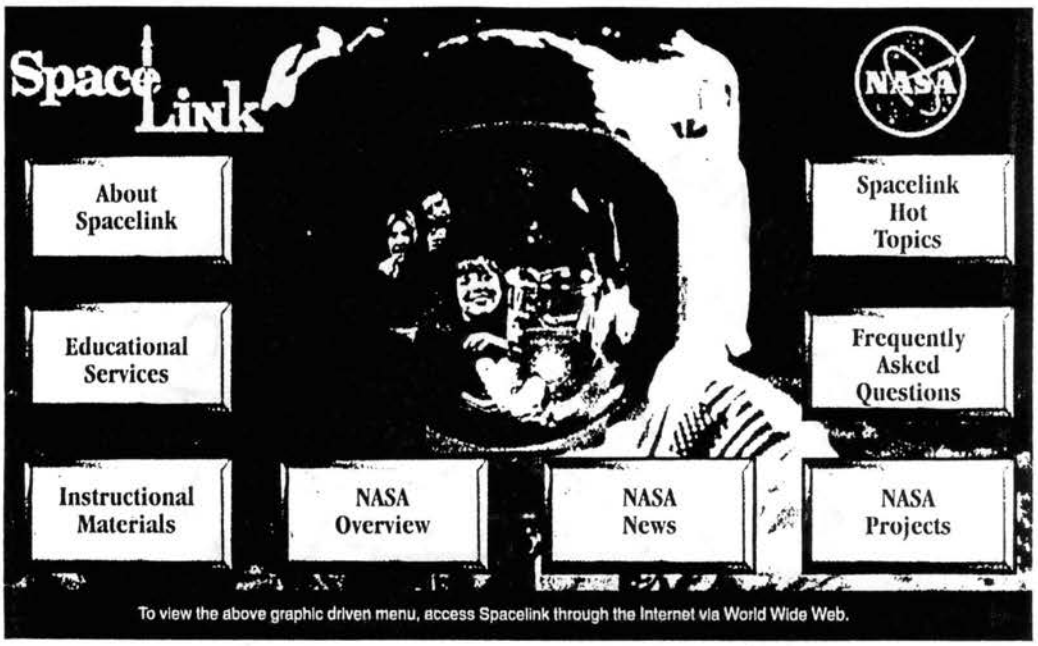
NASA Spacelink Administrator: comments@spacelink.msfc.nasa.gov

Spacelink's modem line is 205-895-0028. The TCP/IP address is 192.149.89.61
The system fully supports the following Internet services:

World Wide Web	*http://spacelink.msfc.nasa.gov*
Gopher	*spacelink.msfc.nasa.gov*
Anonymous FTP	*spacelink.msfc.nasa.gov*
Telnet	*spacelink.msfc.nasa.gov*

National Aeronautics and Space Administration

Educational Service	
Teachers, Faculty & Students	Grades: K - Post Doctoral



NASA Spacelink is an electronic information system designed to provide current educational information to teachers, faculty, and students. Spacelink offers a wide range of computer text files, software, and graphics related to the aeronautics and space program. For callers who reach Spacelink via the World Wide Web, the system offers links to additional educational resources.

Documents on the system are chosen for their educational value and relevance to aeronautics and space education. Information and educational materials are available on topics including:

- lesson plans
- software
- current NASA news
- NASA educational publications
- teaching activities
- historical information
- NASA images
- future projects
- special features available to educators
- NASA educational programs & services
- answers to questions on NASA aeronautics and space-related topics
- schedule for NASA Television

The system may be accessed by computer through direct-dial modem or the Internet.

Modem line:	(205) 895-0028
Terminal emulation:	VT-100 required
Data format:	8-N-1
Telnet:	spacelink.msfc.nasa.gov

Spacelink fully supports the following Internet services:

World Wide Web:	http://spacelink.msfc.nasa.gov
Gopher:	spacelink.msfc.nasa.gov
Anonymous FTP:	spacelink.msfc.nasa.gov
Internet TCP/IP address:	192.149.89.61

For more information, contact: Spacelink Administrator, Education Programs Office, Mail Code CL01, NASA Marshall Space Flight Center, Huntsville, AL 35812-0001. Voice phone: (205) 961-1225
E-mail: comments@spacelink.msfc.nasa.gov

EP-332 October 1995

Search the Spacelink Library

Help on search string patterns for multiple word searches.

Search:

☒ Case insensitive
☐ Match whole word

Maximum number of files to return: 100

Maximum number of matching lines per file to display: 5

Submit Query

Reset Form

NASA Spacelink uses the glimpse text search engine.

NASA Spacelink Administrator: comments@spacelink.msfc.nasa.gov

If you have a Spacelink Educator account select here to connect via telnet.

A Spacelink Educator account provides U.S. educators with additional services including:

- Electronic Conferences - Live keyboard conferences. Spacelink hosts occasional "moderated" conferences in which questions may be asked of guest speakers such as NASA scientists. Or, set up your own conferences to discuss topics of your choice with other Spacelink educators.
- Spacelink Newsgroups - Participate in newsgroups that can only be accessed through Spacelink Educator accounts.
- Spacelink Educator Directory - Identify other account holders geographically or by subject taught. E-mail addresses are provided to facilitate communication between educators.

If you would like a Spacelink Educator account, write on school letterhead to the following address:

Spacelink Administrator
Educations Programs Office
Mail Code CL01
NASA Marshall Space Flight Center, AL 35812-0001

NASA Spacelink Administrator: comments@spacelink.msfc.nasa.gov

APPENDIX E

SPACELINK INTERNET HOME PAGE

CONNECT 14400 9spacelink
Trying 192.112.233.10...

Connected to 192.112.233.10.

UNIX(r) System V Release 4.0 (spacelink)

One moment please....

WELCOME TO NASA SPACELINK

An Aeronautics and Space Resource for Educators

LOGIN OPTIONS:

1) Enter guest (IN lower CASE) then press return (no password required)
2) To disconnect from this system, enter quit then press return

CONNECTION REQUIREMENTS:

Method	Emulation	Settings
Direct Dial Modem	VT100	8 data bits, 1 stop bit, & no parity
Telnet	VT100	

For help with technical problems call the Spacelink Help Line (205)961-1225

login: hard5600
Password:
Last login: Mon Oct 14 14:29:46 from dial-in-services

SPACELINK PROJECT SUPPORT MENU
AEROSPACE EDUCATION SERVICES PROGRAM (AESP)

---

* Electronic Mail & Newsgroups
  + upload a file from workstation
  + lookup a NASA address (X.500)

* AESP Bulletin Board
  + post a file
  + remove a file

* Spacelink Teacher Resource Center (educator access)

* Spacelink Public Electronic Library (public access)

* NASA Spacelink System Statistics

Getting file://localhost/projects/aesp_admin/aesp.html

Arrow keys: Up and Down to move. Right to follow a link; Left to go back.

? Help P PrevCmd R RelNotes
? Help M Main Menu P PrevMsg - PrevPage D Delete R Reply

Really quit pine?
Y [Yes]
N No

Pine finished

Are you sure you want to disconnect from NASA Spacelink? [Y]
Arrow keys: Up and Down to move. Right to follow a link; Left to go back.

telnet: Connection closed.
NO CARRIER

APPENDIX F

RECOMMENDATIONS FOR FUTURE RESEARCH

The following ideas occurred during the time the research was being conducted for this study:

1. Future questionnaires should include demographic data about participants, including: gender, age, years of experience in teaching, grade level taught, subject(s) taught, geographical location of school (state, and whether it is rural or urban), and ethnicity of teacher.
2. Questions on future questionnaires should be structured with statistical procedures in mind. For example, questions should be written so that cells will be likely to contain at least five responses so Chi Square can be used to identify relationships.
3. Future studies will show whether teachers continue to be dependent upon the toll-free access, and the extent to which schools in the country are beginning to be connected to the Internet.
4. A follow-up study should be conducted to determine the reasons for the fact that a number of educators have registered to use Spacelink and then never logged on again. The reasons could include: lack of hardware and connectivity, lack of training and support, failure of Spacelink to provide relevant features and services, teachers having moved to a different assignment or left teaching, or others.
5. A study should be conducted to determine the reasons that one hundred percent of those educators who had logged on for 25 hours or more as of January 1996 use E-mail, but the percents who use other services, particularly conferencing, bulletin boards, and images, are much smaller.
6. Future research regarding the types of hardware, software, and servers being used by Spacelink Educator Account holders would be informative and useful in planning future offerings on Spacelink. For example, are they using PCs or Macintosh platforms?
7. Educators' opinions and suggestions should be solicited regarding the types and forms of training which would be most helpful in making their use of Spacelink services more inclusive and productive. Would they prefer user manuals, half-day workshops, one-on-one instruction, or other methods?
8. A study should be done which will elicit more detailed information about how Aerospace is being used in the curriculum. The information should be grade-level specific, and elicit real numerical data about how many activities are used in each classroom, whether aerospace is being used to integrate disciplines, and how Spacelink is functioning in meeting curriculum needs.
9. Future research should include questions concerning awareness, availability, and cost of local Internet connectivity. Subjects should be asked if they would use Spacelink if there were no toll-free number available. Future research should determine the cost of using local commercial servers, whether teachers are aware of other sources of funding for school connectivity, and what the attitudes of teachers are about spending personal funds to get connected.

10. Future research should study the percentages of each session spent on E-mail, Spacelink features, the Internet, and downloading files. It would be useful to know whether there is a statistically significant correlation between how many times per week users log on and the length of each Spacelink session.
11. Future research should inquire as to how many times subscribers log on each day, during which hours of the day they log on most often, which days of the week subscribers log on most, and during which months Spacelink is used most by educators. A longitudinal record of the times and lengths of log on periods would be informative. This would help in planning special services and opportunities for Spacelink Educator Account holders.
12. Future research should inquire as to the make, model, age, and capabilities of the computers in the classrooms. If the computers are older models their capabilities may not include communication by modem. If their disk space is limited they may not be able to handle the software and storage requirements for electronic communication. If their operating systems are not user-friendly, teachers and students may find them intimidating or threatening, and they may not be making use of their potential as a resource. Respondents should also be asked whether the computers in question are equipped to communicate with Spacelink, and whether the teachers are comfortable and confident in using them.
13. Future research should establish whether Spacelink Educator Account holders have other E-mail addresses and whether they would be using the information on the public access part of Spacelink even if they did not have the Educator Accounts.
14. Future research should investigate how many students have Internet connectivity in their homes. It would be interesting to compare the comfort level and confidence in using on-line resources between the teachers and the students.
15. Future research should establish whether or not inservice training in educational technology is available at all. It would be useful to know whether the training is mandatory or optional, whether other sources of training are available and are being used, and how teachers feel about becoming trained to use educational technology. It is important to learn whether teachers see technology as yet another task being added to their already overfilled schedules, or as a way to expedite and enhance the work they are already doing.
16. Considering the responses to questionnaire item nine, it would be useful to engage in additional research to determine why, since the training is available, teachers have not taken advantage of the opportunity. Future inquiry should be pursued to learn the reasons for this situation.
17. Future research should include inquiries as to where teachers turn when they need help, and whether they would use their computers more effectively if that assistance were available on site.

18. Future research should include questions on the teachers' level of awareness of the science and mathematics applications of aerospace concepts, and their attitudes about using these concepts to supplement and integrate these disciplines.
19. Future research should involve restructuring questionnaire item 16 to better reflect the actual practices and attitudes of the teachers concerning the use of aerospace activities in their classrooms. The high percentage which felt the question was not applicable indicates a misunderstanding as to the content of the question. The teachers should be given the opportunity to express themselves in a more subjective form.
20. Future research should study ways in which the service could be enhanced and improved to reach more teachers and better meet the needs of those who are already connected.
21. Future studies should examine the correlation between the number of NASA Teacher Guides accessed and the number of users who are using the graphic interface available on the World Wide Web.
22. It would also be useful to know how the educators became aware of the availability of the NASA Spacelink toll-free educator accounts. Spacelink Educator Accounts are introduced and distributed at the conferences and workshops mentioned in questionnaire item 19. Limited numbers are also distributed through NASA Field Centers. Future research should seek to determine how many of the teachers who have been given toll-free account numbers have actually activated and used them, and also how the other teachers who are using toll-free accounts received them if not through the above-mentioned conferences and workshops. This information would assist in planning future distribution practices and assessing the demand for the service.
23. Future research should examine the relationship between the use of Spacelink and other on-line resources and the interests, attitudes, and education level of teachers regarding professional development.
24. It would be useful to learn whether those teachers who do not have local technical assistance feel that they are inconvenienced or impeded by this lack of assistance.

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VITA

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Candidate for the Degree of

Doctor of Education

Dissertation: USE OF AEROSPACE ACTIVITIES IN THE CLASSROOM BY TEACHERS WHO HAVE ACCESS TO NASA SPACELINK

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