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The Effect of Technology-Rich School Environments on Academic Achievement and Attitudes of Urban School Students

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Urban School Students

by

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Abstract

The purpose of this study was to examine the effect of technology-rich educational environments on student academic achievement and attitude. The primary independent variable was the type of school (technology-rich school (TRS) and traditional school (TS)). Additional independent variables included gender, ethnicity, and computer ownership. The dependent variables were: 1) student academic achievement (Iowa Tests of Basic Skills (4th-grade), Virginia's Literacy Passport Test (6th-grade), and Tests of Achievement and Proficiency (11th-grade)) and 2) and student attitudes (questionnaire).

The design examined the differences between TRS and TS (N = 1088). Compared were 4th-grade elementary school students attending a TRS (n = 47) and a TS (n = 42); 6th-grade middle school students attending a TRS (n = 337) and a TS (n = 244); and 11th-grade high school students attending a TRS (n = 248) and a TS (n = 170). An examination of pre-treatment academic achievement data indicated no significant differences between the treatment and comparison groups.

Academic achievement findings indicated that: 4th-grade TRS students' ITBS scores were higher than 4th-grade TS students (p = 0.0441) based on type of school and computer ownership; 6th-grade TRS students' LPT scores were higher than 6th-grade TS students (p = 0.0071); 11th-grade TRS students' TAP scores were higher than 11th-grade TS students (p = 0.0009), based on the interaction of type of school, gender, and ownership.

Attitude findings indicated that: 6th-grade TRS students had higher attitude-toward-school scores (p = 0.0001) and composite-attitude scores (p = 0.0044); 6th-grade TRS students had higher attitude-toward-school scores (p = 0.0121), attitude-toward-technology (p = 0.0176), and composite-attitude scores (p = 0.0042) based on the interaction of type of school, gender, and computer ownership; 11th-grade TRS students had higher attitude-toward-school scores (p = 0.0116), attitude-toward-

technology (p = 0.0095), and composite-attitude scores (p = 0.0047); and, 11th-grade students had higher attitude-toward-school scores (p = 0.0334) based on the interaction of type of school and gender. The overall findings indicated that TRS environments contribute to increased academic achievement of 4th-grade, 6th-grade, and 11th-grade students and contribute to positive student attitudes toward school, technology, and overall attitude for 6th-grade and 11th-grade students.

PROLOGUE

Molecular recognition systems, neural and semantic networks, and television-based data retrieval and storage systems are quickly becoming 'standard' applications of technology. These technologies are based upon interconnected micro-chips which are becoming increasingly faster, more powerful, less expensive, and more common-place in business and industry. Students are thrust into this world of work--a world inundated with technology. Today's students may, or may not, be prepared for this increasingly complex technological age, depending on the visionary actions of today's educators. Within themselves, educator's must have a 'vision' of tomorrow and the skills to influence the educational offerings in today's schools. Unfortunately, many educational leaders may lack the technology skills necessary to change today's schools and to truly equip students for tomorrow's world of employment. Schools have an obligation and a public trust to prepare students in the use of technology. Infusing schools with technology and creating technology-rich educational environments will not resolve all the social and economic problems confronting today's students, but these two steps will provide acceptable future employment skills and improve the quality of life for those students who hope to become the contributing citizens of tomorrow.

Dedication

I dedicate this work to the 97 out of 100 children
who exist outside the United States in decaying,
hostile, and dangerous urban environments.
Deprived of the basics of life by a fate of birth,
may enlightened educators acknowledge the need to
research the urban environments
of these children.

A special dedication to
Donnie E. Akridge -- a fellow student and comrade.

Finally, I dedicate this work to my daughter Susanna M. Grimm,
who at age 11 knows more now than she will at 30.

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Table of Contents

List of Tables

Chapter 1

Reports of the creation, development, and emergence of the Information Age and one of its integral parts, the "Information Superhighway", fill the popular press. Increasingly, the much heralded information superhighway is a topic for discussion and speculation. From all quarters, ideas abound on the highway's configuration and its potential impact on society. The creation of an information superhighway, with national and global interconnections, has the potential to revolutionize how people conduct their business and domestic affairs. This information highway is but one aspect of the dawning Information Age and the emergence of a technological culture based on computer technology. Preparing students for the Information Age is a critical task as attested by the U.S. Department of Education which states that there is a "...need for schools to be positioned at the forefront of the technological revolution..." (1994). However, an even more essential mission for today's educators is determining how to prepare today's children for tomorrow's technological society.

Tomorrow's World

The introduction of new technology precipitates changes in the existing cultural condition. As was seen in the Industrial Revolution, significant changes in global culture were spurred by the new technologies introduced during that era. The anticipated societal changes wrought by the emerging Information Age are expected to be unprecedented and even more radical than those of the Industrial Revolution. Technology, as a determinant of culture, challenges existing systems, processes, and procedures. Tomorrow's world will be markedly different from today's world in many aspects of human endeavor.

The current technological revolution will create a remarkable world for the citizens of tomorrow. Information, gathered and relayed, will provide the foundations of a new technology-based civilization. Many daily, routine human activities will be profoundly affected by this revolution. The typical citizens of the Information Age will engage in banking, health care, shopping, and entertainment activities through computer-accessible networks. Cyber money will become the medium of exchange. People and organizations will conduct financial transactions through banking databases and automated processes. Interconnected computers, with various input devices, will link doctors, patients, and medical databases. Health-related artificial intelligence programs will provide immediate diagnoses coupled with recommended prescriptions for patients. Multimedia technologies will permit people to access product databases, permitting national and international shopping through interfaced computer terminals. Rest and relaxation will be accomplished through virtual reality vacations to the places of a person's dreams. These profound changes in the human routine will be reflected in the world of employment also. Citizens of the future will find a different work environment. Jobs will involve selling "...information and innovation, management, culture and pop culture, advanced technology, software, education, training, medical care, and financial and other services to the world" (Toffler & Toffler, 1993, p. 22).

Although literature, magazines, newspapers, and journals will continue to provide the printed word, their formats will be electronic. Tomorrow's citizens (today's students) will face an automated world. Common enterprises will require the skills and knowledge necessary for accessing information, expanding data links, and processing information rapidly. Most, if not all, routine functions will be performed by computers. Multimedia communication for a myriad of activities will become the norm, not the exception.

The charge of preparing tomorrow's productive adults falls squarely on today's schools. Even as technology has changed in the recent past, it will surely change in the near future. Information technology, as it expands, will result in swift cultural changes. Simply to be productive in the future, people will need to know much more. The Information Age will provide little charity for those who avoid learning about computers and related technologies. During the Information Age the "uneducated or unskilled workers are [will be] made jobless" (Toffler & Toffler, 1993, p. 22). Rockman (1993) maintains that the business community will require better educated workers in the future. However, not only will workers need to be better educated, but they will also need to learn skills different from those they are learning today. That is to say, today's employment skills may not suffice in tomorrow's work environment. Perelman (1993) reports that American business conducts training programs for greater than two-thirds of American workers. They are expected to learn the skills needed for the technology intensive world of work. As technology continues to enter the work place, training and re-training programs may become more common in industry. A central requirement of the imminent Information Age is educating people to function in a technology-based culture.

In the future, knowledge will belong to those who know how to gather, glean, and process information using technology-based systems. Indeed, it is possible that those unprepared for the Information Age may not reap many rewards in their personal or professional lives. Referring to the impact of technology on society, Perelman (1993) writes,

> The fabric of whole societies is being rewoven around the globe. Every major social structure is subject to reappraisal, redesign, and replacement. Inevitably, the challenges of the dawning knowledge age will demand that the

> most conservative social glue, education, be reinvented as well. (p. 79)

A requirement of educators, then, is to identify the technology-based skills needed of tomorrow's citizens and to develop those skills. Pallas (1991) states "...there are fewer and fewer jobs for the poorly educated" (p. 20). Naisbitt and Aburdene (1990) assert,

> The information economy is producing an extraordinary number of well-paying, challenging jobs. However, you [workers] must possess the required skill to do those jobs. Tragically, the unskilled, undereducated will command salaries that match their economic value in an information society -- not very high. (p. 42)

Ginsparg (1993), referring to the scientific and research community, speaks about the requirement for workers of tomorrow to access information about "everything." In the Information Age, success will depend on accessing knowledge quickly and efficiently.

However, because of the rapidly changing nature of technology, it takes more than just teaching *about* technology to produce an employable person. Comer (1987) maintains that,

> ...through the industrial to the current technological economy, the job market has dictated each era's education needs. Today, those needs require a very high level of psychosocial and academic development for children to be successful both in school and later in life. (p. 13)

Bialo and Sivin (1989) report that the most important impact of technology on students is in the affective domain. An additional significant requirement exists to create positive attitudes about technology. Attitude generally influences the accomplishments of people in their personal and professional lives. Given that technology is *the* foundation of tomorrow's Information Age, schools must cultivate positive student attitudes toward technology and foster students' confidence in their abilities to use technology effectively. With effective exposure to technology, positive attitudes towards education, computers, and self may replace students' fears of computers and technology.

The effect of technology is an attitude of empowerment expressed by students who use computers (Swan, 1990). Empowerment is the understanding of technology as a tool, directed in a functional and productive manner. Preparing today's students for tomorrow's world of technology is an absolute requirement of today's schools.

Traditional Educational Environments

Spurred by the education reform movement, American schools pursue education excellence. Unfortunately, limited by financial constraints, many schools find it difficult to embrace the concepts of a high-tech learning environment. The technology gap is widening between our educational enterprise and the world of work (Perelman, 1993). Business and government are adopting technologies to meet their functional requirements; however,

> ...schools--lacking clear and consistent guidance--continue with the system designed nearly 100 years ago for the needs of business organizations that are now quite different. (Secretary's Commission on Achieving Necessary Skills [SCANS], 1991, p. 5)

In many schools, the cultural fabric of the school is unable to fully integrate technology. Constrained by Federal and state regulations, schools sense limited educational choice, thereby reducing, if not eliminating, the flexibility and creativity of both teachers and students (Department of Education, 1991). Allen (1992) declares that,

> The current framework and structure of education is so flawed and fragmented and patched and gerrymandered that the costs of restoring it are far beyond its worth as a structure.... Let the present structure of education take its place with the little red schoolhouses. (p. 5)

The traditional educational process meets the legal and professional requirements of providing access to education. However, the SCANS report (1991) states, schools "...are failing to develop the full academic abilities of most students and utterly failing the majority of poor, disadvantaged, and minority youngsters" (p. vi). As Pallas (1991) notes, "...differing backgrounds and experiences imply that students have different educational needs" (p. 19). The traditional, unchallenging educational pattern regiments the instinctive curiosity of children, eliminating the natural joy of learning. Critics maintain that schools, because of their approach to education, contribute to the problems of low academic achievement scores, increased drop-out rates, poor discipline, and low student self-esteem rather than ameliorate them. Nonetheless, schools are not totally responsible for societal issues, which are often reflected in criticisms directed toward schools. Valid criticisms, however, can be leveled at the methods schools employ to provide education.

There are exceptions and variations in traditional schools, but in many cases, American education fails to *captivate* students and engage them in the learning process. Pallas (1991) states "...schools lack 'certain knowledge' about how they should go about doing their jobs" (p. 20). Ill-equipped to meet today's needs, many schools find it difficult, if not impossible, to meet students' needs for the Information Age. Today's students require enhanced technology skills in preparation for tomorrow's world of technology. Student access and exposure to technology-based environments are not luxuries, but definite requirements for an effective educational process. What is necessary is a restructuring of schools for the purpose of providing students with technology experiences. Clearly, these experiences should reflect what will be necessary for students to meet tomorrow's technology needs.

Technology-Rich Schools

Hampton City Schools believes the emerging Information Age has major implications for its students. Comprised of 33 schools, this system has adopted the concept of smart schools--technology-rich schools. In the belief that the concept can be a forerunner of tomorrow's schools, Hampton is creating technology-rich environments. The approach is to "lure" and "entice" recipients (both students and teachers) by offering interesting educational opportunities. Rather than forcing technology onto unwilling participants, technology is the vehicle which provides new and exciting opportunities. Most important, Hampton does not dictate guidelines and directives for technology use, but instead, provides assistance to facilitate creative application of the technology available. The technology-rich concept involves individual school consensus, acceptance of technology, provisions for equipment, assignment of personnel, encouragement for utilization, and expansion of a technology base.

<u>Characteristics of a technology-rich school.</u> There are three major characteristics of technology rich schools: internal connectivity, external connectivity, and adaptability. These characteristics are an acknowledgment that a technology-rich educational environment, as defined by Hampton, is more than just a school with an array of technology-based equipment. Rather, the characteristics represent a set of standards for the *creation* of technology-rich environments. The

purpose is to transform the traditional school's environment into a technology-rich one, not only in name but in ideology.

Internal connectivity links teachers, administrators, and students to the central information center. The central information center is comprised of a computer file server and accessible databases located within the school. For example, students' class grades can be uploaded to data records and made available to counselors and teachers. Teachers may also use the internal connectivity of the school to transfer data within the school. In this design, the hub of the technology-rich school is the school's library which serves as an information resource center. Based on its requirements, the school determines the composition of the central information center. Data from the centralized information source are accessible throughout the technology-rich school.

External connectivity allows schools to receive and send electronic mail, conduct electronic teleconferencing, and access external databases globally. For example, faculty and staff can access Virginia's Public Education Network (VA-PEN) to download the most recent information concerning issues in education through the Electronic Academical Village. Newsgroups and discussion groups provide information concerning a variety of topics (e.g., educational and resource topics). Students, teachers, and administrators throughout the nation and the world can gather and share data. External connectivity provides Internet access (e.g., World Wide Web) for data and information gathering and exchange. Wide access to information is a central theme in the technology-rich environment.

Adaptability allows faculty and staff to use various technology-based capabilities to present subject matter and to adjust the curriculum. For example, mathematics teachers may supplement their algebra instruction with the use of computer-based software programs. The adaptability of the technology-rich environment enables school personnel to adjust, change, innovate, and explore new approaches to educational processes. Adaptability empowers faculty and staff to use and modify the technology base to enhance and expand learning prospects for students as exemplified by the creative use of a robotics laboratory at the middle-school level. Faculty, staff and student empowerment is the primary goal of Hampton's technology-rich concept. The technology-rich concept is the approach the Hampton district has taken to create tomorrow's schools. Each technology-rich school uses the installed technology-base in a different manner, depending on the student's grade level. However, all schools use their technology-base for individual and group projects as a mode of instruction. The project-based learning strategy permits an assortment of educational endeavors to be conducted by individual students or groups of students working toward a common academic objective. Used as a tool, the school's technology-base allows students to learn basic facts, conceptualize specific topic areas, and then gradually expand their knowledge-base in seeking additional facts for projects and reports. The cooperative nature of technology-based projects is suited to group learning and to sharing of information among students. The use of the technological tools is intended to engender creative and self-directed student thinking in an individual and group mode.

Implementation of technology-rich schools. Bethel High School, Syms Middle School, and Cooper Elementary School are three schools which use the individual and cooperative projects strategy in the context of a technology-rich environment. Kecoughtan High School, Davis Middle School, and Cary Elementary School, are traditional schools and comprise the comparison group. Each technology-rich school will be addressed separately for the purposes of clarity and treatment definition.

Bethel High School

Bethel High School, a technology-rich school since 1990, has 1744 students, a faculty of 106 teachers, and 11 staff members. Twenty-nine of Bethel's 75 classrooms have at least one installed computer. The internal network is comprised of an Ethernet which interconnects computers with an Apple Macintosh 950 central file server. External connectivity is provided by modems connected to a central mainframe, permitting Internet access.

Student use of, and exposure to, technology. The goal of the technology-rich school is to influence students by encouraging utilization of the school's technology to foster problem solving and creative thinking. Bethel's two primary approaches to increasing student exposure to, and use of, technology are 1) integrating technology into course work and 2) using technology in laboratory and library settings.

Technology integrated into course work. Courses taught at Bethel incorporate technology into daily student activities. English is required of all Bethel students. The course is 36 weeks long and meets every other school day for 105 minutes and incorporates the use of technology through word processing, graphics creation, and electronic researching. For example, students create individual booklets about poetry by studying the history and construction of poems. Information from the school's electronic and non-electronic resources is gathered in the initial portion of the project. Subsequently, students create their own verses in a variety of styles using graphics to enhance their creations. Finally, the completed student projects are published in the form of booklets. These are made available for other students and teachers to read.

The creation of a student literary magazine is another instance where technology is incorporated into course work to solve a real-life writing and publishing problem. Students research literary materials using school and other resources. They import material into a computer program, conduct design and layout activities, and produce a camera-ready copy for offset publishing. The completed publication is disseminated to other students, and a copy is housed in the library as a reference source.

An example of computer usage in a different subject area is a project engaged in by a social studies class. Groups of students in a social studies class use technology to produce a birth control pamphlet. The creation of the pamphlet is an exercise in synthesizing information, evaluating the various levels of importance of that information, and then determining which information is essential for distribution among teenagers. This use of higher level thinking skills results in the utilization of the technology base to download facts, figures, and demographic data from local, national and international sources; acquire local names, phone numbers, and organizational addresses; and publish and distribute the pamphlet to other students via the library and the school nurse's office. Not only is knowledge acquired by electronic means, but it is organized, synthesized, evaluated, published and disseminated. Other student technology oriented projects include the creation of a family newspaper, class newspaper, children's books, portraits of heros, Young Authors books, and the writing of original musical compositions by students in chorus and music theory classes using a music composition program. Computer Math for 11th-grade and 12th-grade students is another technology oriented course. The classes meet for 105 minutes, every other day for 36 weeks. Computer Math provides an expanded foundation in the use of computers, terminology, programming, telecommunications, and various types of software with a focus on mathematics. One example is that students use graphing calculators to predict, check, and solve algebraic and calculus equations. In another activity, students design a math book which assists second-grade and third-grade students in the acquisition of math concepts. Bethel's students research existing material used by 2nd-grade and 3rd-grade students, compile a list of mathematical problems, and enter data and problems into the computer. Subsequently, the information is published locally. In the math-book-creation project, technology is used for problem solving and for deductive thinking.

The Computer Applications course meets for 105 minutes, every other day for 36 weeks. This class provides a foundation in the use of computers, terminology, printing, database management and use, and spreadsheets. For example students write a computer program designed to teach a lesson on a topic of their choice. Students incorporate sounds, text, and graphics into a multimedia presentation. Presentations are made to fellow students and parents. In another event, students create an information database of facts concerning America. Maps of U.S. states are electronically linked to the appropriate state capitals. An electronic procedure subsequently links a U.S. map, state map, state capital, and individual state database with the information about America. Other activities require students to create their own databases and then output the databases in different formats (e.g., limited, delimited, and parsed). Students create an original screen graphic using True Basic programming skills. These activities are representative samples of student exercises in the Computer Applications course.

Some final, brief examples of additional technology integration into course work follow. In technical drawing and engineering classes, students use computers to create drawings, research topics, and compose reports, presentations, and papers. In business courses students use computers to conduct Internet scavenger hunts; perform data entry, word processing, and accounting activities; transmit material to parent's work sites and receive replies using a facsimile machine; and, create computer generated pictures which are donated to a local pre-school. Spanish class students use telecommunication capabilities to access a database at the University of Guadalajara, Mexico, to gather information on famous artists. On an average, due to the integration of technology into course work, an individual student spends 10 to 30 minutes per day using computers, depending on the course, project, and work assignment.

Use of technology in laboratory and library settings. At Bethel, the use of special function laboratories and the library are the primary means of providing students exposure to, and use of, technology. The laboratories and library are equipped with, or have available, computers, printers, network modems, CD-ROM and VCR players, scanners, camcorders, laserdiscs, cassette recorders, interactive videos, and TV. Accessible information resources and software include an on-line card catalog, True Basic, Microsoft Works, ClarisWorks, Writing Center, Compton's Encyclopedia, Grolier's Encyclopedia, EBSCO Magazines, NewsBank, Guinness Book of World Records, SIRS, Poetry Finder, and additional database, spreadsheet, and publishing products.

The library, available to students eight hours per day, has over 20,000 print and non-print titles, sound filmstrips, videos, software programs, records, CD-ROM, laserdiscs, and other audio visual and computer products. On an average day, the library staff spends seven manhours working with teachers (e.g., introduce teachers to new resources and provide technology assistance), two manhours in planning meetings, two manhours preforming administrative duties, and seven manhours teaching or assisting students in research. An individual student spends five minutes to 105 minutes in the library weekly depending on the project or class assignment.

For example, the library staff provides assistance to students in the use of the electronic card catalog and data retrieval from various CD-ROM products. The staff also assists students in the use of software and other technology applications (e.g., MacGlobe, MacFrog, and Point of View). Students use the library's resources to conduct research for special projects. These projects might include researching a selected topic, creating a report or presentation, and printing the project using the library's computers and printers. Also, many students use the library's electronic systems to retrieve information and illustrate, type, and print books and reports for classroom assignments.

In another activity, students at a local elementary school collaborate with Bethel students on the creation of a 'friendly' alien. Bethel students read elementary school library books, create text reviews of the books, incorporate graphics, merge material into HyperCard stacks complete with bookmarks, and publish a book using desktop publishing programs. Additionally, Bethel students create a model of the 'friendly' alien, which, along with the HyperCard stacks and published book of reviews, is provided to the participating elementary school as a reference book. Teachers believe these research and production operations enhance basic knowledge skills as well as higher level cognitive skills by encouraging student curiosity, ingenuity, and creativity.

Among the laboratories at Bethel are *The High Performance Computer Center Laboratory, the English/General Laboratory, the English/Publication Laboratory, the Writing Laboratory, the General Laboratory,* and *the Mathematics Laboratory.* The laboratories are designed to allow students to learn and practice a wide variety of advanced technology-based skills, in addition to learning and practicing mathematics, reading, writing, English, and research skills. The laboratories are generally available to students seven hours per day for group or individual projects and open to all curriculum and subject areas. Students spend one hour and 45 minutes daily in the laboratory using computers or other available forms of technology to accomplish educational tasks. These laboratories offer the students the drill and practice time and equipment needed for honing their basic knowledge skills, and also they offer students numerous occasions for comprehension, application, analysis, synthesis, and evaluation of collected information.

For example, students select historical topics (e.g., France, Golden Gate Bridge, and New York) to research and present using multimedia techniques. Students gather information from electronic encyclopedias, printed publications, and other sources. Information concerning the historical topic and acquired data are incorporated into a presentation software program along with digitized sound, film, and text. The students then display their completed multimedia electronic presentation to the class.

In other activities, students use electronic mail (E-mail) to establish communications with students in other countries (e.g., Norway and Spain). Bethel students send E-mail messages which share American living and learning experiences with students in other countries. In return, the Bethel students receive E-mail messages in which they learn about other ways of life. Bethel students use technology to solve "seasonal" real-life problems like how to answer 900 letters for Santa Claus and Frosty the Snowman. An advertising campaign directed toward elementary-school students announces two addresses for Santa Claus and Frosty the Snowman. Elementary-school students write letters to one of the two addresses. Bethel's students, using technology, respond to over 900 individual letters.

On other occasions, students send letters to famous persons requesting their favorite recipes. The recipes are collected, consolidated, and entered into a database. Text, graphics, and database information are incorporated into a publishing program. The published product is a chocolate recipe book to benefit the Alzhemiers Association. Other published products, such as the school's newspaper or autobiographies, are created by students and published using laboratory resources. Research information is digitized and merged with text and graphics, and eventually printed. Information concerning American manufacturing and distribution is acquired (downloaded) from internal or external electronic sources. This download is incorporated into HyperCard stacks with the completed project being an electronic presentation about American manufactured products. The intent is to establish a framework for students to learn in a self-directed and creative manner.

Students conduct research to create multi-cultural, multimedia presentations. Using electronic and manual research techniques, students produce HyperCard stacks of information concerning different cultures. Sound, graphics, pictures, and text are merged into a multimedia presentation. A driver's education class uses the school's technology as the focal point of learning. After reading safety and driving manuals, students use technology to create bumper stickers, cards, and flyers advertising safety. A geography class conducts research of foreign countries. Information is acquired and data downloaded. This information is incorporated into spreadsheets and graphic programs for the creation of graphs and charts displaying statistics (e.g., populations, products, and land mass) about the countries.

These examples are evidence of how technology can be utilized to prepare students for a technology-oriented future in the private as well as the public sector. The projects and activities illustrated are not purely academic in nature, nor are they totally vocational/technical; however, they provide students with opportunities to develop abilities needed for the information age job market. The intent is that the decision making skills and the technical skills acquired are those which will be useful in in-school and out-of-school life situations.

Summary. Bethel High School is a technology-rich school. Students have access to computers on a daily basis and use that technology for the purpose of problem solving. Many of the student, technology-based activities are not possible in traditional schools; therefore, the higher level cognitive skills which technology-based activities require are neither tapped as frequently nor as regularly as they are in the technology-rich schools. Decisions as to which sources of information, method of access, and reconstruction of information into a report or a project are important components of technology situations in which Bethel students immerse themselves every day. Incorporating the effective use of technology, the Bethel learning environment is designed to meet local and state curricular requirements and prepare students for tests which have moved toward higher cognitive skill standards. Furthermore, this environment prepares students for the cognitive rigors which they are sure to encounter in the Information Age society.

Syms Middle School

Syms Middle School, a technology-rich school since 1992, is a Hampton school serving over 1,200 6th-grade, 7th-grade, and 8th-grade students. Syms is 90% internally networked through an Ethernet cable system, connecting classrooms, laboratories, and administration to a central file server. External connectivity is provided by modems connected to a city mainframe through a dedicated telephone line permitting VA-PEN and Internet access. In addition to networked computers, other technologies in the school include scanners, VHS, laserdiscs, and CD-ROM players, and camcorders.

Student use of, and exposure to, technology. The goal of the technology-rich school is to impact students by encouraging utilization of the school's technology. Efficient school administration through automation and technology-trained teachers contributes to student use of, and exposure to, technology. Syms Middle School has four approaches: 1) required technology classes, 2) courses with technology use integrated, 3) use of computers in classrooms, and 4) use of technology in laboratory settings.

Required technology classes. The foundation of Syms's technology-rich school is the use of technology by students. As a school policy, Syms has established four required technology courses: Computer Essentials, Introduction to Technology classes, Inventors and

Inventions, and Technology Systems. Syms requires all 6th-grade students to enroll in Computer Essentials and Introduction to Technology classes.

Computer Essentials provides a foundation in basic computer operations, as an interdisciplinary tool. The class meets for 45 minutes, five times each week for seven weeks. *Introduction to Technology* provides an expanded foundation in the use of computers, terminology, video, printing, and types of software. The class meets for 45 minutes, five times each week for seven weeks. *Inventors and Inventions* is 18 weeks long and meets five days each week for 45 minutes per day. The focus of the class is the increased use of the technology-rich educational environment through the application of technology to various projects. *Technology Systems* focuses on expanding students' understanding of technology. The class is 36 weeks in duration and meets five days per week for 45 minutes per day. The mandatory technology classes are designed to prepare students for their middle school experience and familiarize them with technology.

Courses with technology use integrated. Almost all courses at Syms Middle School use technology in some aspect. Courses employ computers, software, CD-ROM programs, and laserdiscs to present material and conduct student oriented projects. Science, a core curriculum subject, is 36 weeks in duration and meets five time per week for 45 minutes per day. For example, Project Alliance, funded by the National Science Foundation, involves students in researching the environment. The external connectivity of the school's technology-base is used by students to communicate with sponsors in Washington D.C. and a school in Pennsylvania. Students not only learn about environmental issues, but also may apply skills in reading, writing, and research for the creation of reports and electronic communications.

Social Studies, a core curriculum subject, is 36 weeks in duration and meets five time per week for 45 minutes per day. For example, using pictures acquired from sources (e.g., electronic media, books, and magazines), the photos are digitized, imported into a software application, and merged with student-created text to develop an electronic field trip. Students provide formal electronic presentations to classmates and teachers. Projects, both individual and cooperative, require students to synthesize information by linking thoughts with the text and the visual image.

Computer use in classrooms. Computers are also installed in classrooms for teacher and student use. The computers generally have word processing, graphics, games, telecommunications, and spreadsheet software installed. On an average day, students in each class use the classroom computer for approximately 20 minutes. The most frequent uses of the classroom computer by students are for word processing, special projects, preparation of classroom reports, skills practice (reading, writing, and mathematics), graphic presentations, card catalogue access, research, and educational games. Classroom computers are available to students for educational projects.

For example, students visited the Virginia General Assembly on a school trip. Students then used the classroom computers to create group reports about the day's events. Subsequently, a newspaper was created containing pictures taken on the trip and text describing activities. A similar class newspaper was created based on research of the Olympics. Cooperative class projects, such as the one just described, provide a basis for students to share information, and thereby, gain additional insight into the interrelationship of type and sources of information.

Other projects using classroom computers have included: HyperCard used to create group presentations of U.S. presidents; picture books researched, written, and printed for 1st-grade students; brochures produced on regions of the U.S. (researched, text created, pictures drawn, and printed); a class newspaper created based on tape recorded interviews with students and staff; and science projects completed using the scientific method, word processing, and graphic technology to create group reports. In a geography class, students participated in Project CAZVA (Climates of Arizona and Virginia). The project involved students in recording temperature and climate data in their respective regions and using telecommunication capabilities to convey data to their respective counterparts. Information was entered into spreadsheets, analyzed, and group reports were created. Although geography skills and knowledge were used, information from other subjects was incorporated into the cooperative project. The real life application of math to the geography topic reinforced the importance of ancillary subject areas. These types of activities required students to organize, synthesize, evaluate, and present information, thus contributing to the development of higher level cognitive skills.

Use of technology in laboratory and library settings. At Syms, the use of special function laboratories and the library provide students other opportunities for technology exposure and use. The laboratories and library are equipped with, or have available, computers, printers, network modems, CD-ROM and VCR players, facsimile machines, scanners, camcorders, laserdiscs, cassette recorders, satellite TV, and interactive videos. Available information resources and software include ClarisWorks, MacPaint, Number-Maze, Number Muncher, Flight Simulator, Oregon Trail, Writing Center, Compton's Encyclopedia, Grolier's Encyclopedia, Carmen San Diego, Programming with LEGO, PowerPoint, Excel, Space Shuttle, and Alge Blaster.

The library has over 10,000 books and access to 12,000 audio visual products which include, 144 video tapes, 500 software programs, 28 CD-ROMs, six laserdiscs. The library is available to students 8 hours per day, and an individual student will spend an average of 40 minutes in the library. On a typical day, the library staff spends 200 minutes working with teachers (e.g., teaching the use of the CD-ROM version of Compton's Encyclopedia and Grolier's Encyclopedia), 15 minutes in planning meetings, 45 minutes preforming administrative duties, and 300 minutes teaching students or assisting students with projects. For example, students use the library's electronic systems to research topics, retrieve information, write, illustrate, type, and print reports and books for classroom assignments and science fair projects.

The Physical Science Laboratory, The Writing Laboratory, and *The Electronic Learning Center* provide the laboratory support to students. During a normal school day, students spend 45 minutes per day conducting activities in the laboratories, which are available six hours per day for individual or group projects. The laboratories are designed to allow students to work with technology in a number of subject areas. All laboratories have a wide variety of hardware and software to support educational activities.

One laboratory is dedicated to presenting science concepts with a focus on robotics. Students use the computers to learn general physical science facts and skills and to conduct robotics programming (LEGO). Students build working models of today's technology (e.g., engines, conveyor belts, and loaders) using LEGO robotics kits. Students also conduct computer programming activities to control the pattern and movement sequence of student built robotics models. On a normal Friday, students in all classes attending the laboratory have a Challenge Day. Working in pairs, students create a model to solve an assigned problem. Upon completion, students demonstrate their design, define which approaches worked, which didn't, and why their creation solved the assigned problem. The projects, individual and group, require deductive thinking and problem solving skills. The intention is that students work in a cooperative technology environment which fosters collective thinking for the synthesis of information in order to complete the assigned task.

Other laboratories are designed to allow students to learn and practice reading and writing skills. For example, the laboratory is used for a poetry unit which teaches students about forms of poetry. Students produce HyperCard stacks of poetry, create slide shows, make class presentations, and print reports. In preparation for dissecting frogs in science classes, students in the laboratory experience a technology-based science class which incorporates science and writing. During this activity, students use the program Introduction to Dissection (CD-ROM) which explains the process of dissection. Students examine the anatomy of a frog using the computer program, The Frog; research the frog using various electronic media; and write a poem, using HyperCard, about the environment, life, and habits of a frog.

Students in social studies and language arts classes use laboratories to conduct technology-based projects. For example, students use laserdiscs and other electronic media to gather information about the 1920s and 1930s. They acquire photographs which are digitized by using a scanner. Students write text based on research material, and merge text and graphics to create a newspaper, addressing events in the 1920s and 1930s. These educational activities, foster not only the development of technology skills, but emphasize the synthesis of information, evaluation of available information, and the presentation of information.

Remediation efforts are conducted in the Writing Laboratory and the Electronic Learning Center. For example, selected students are pulled from class two times per week to engage in 45 minute sessions for improving reading and writing skills. In another example, specific students are pulled from class two times per week to engage in 45 minute sessions for Literacy Passport Test (LPT) remediation. All the hardware and software programs in the laboratories are used, when appropriate, to conduct remediation efforts.

Summary. Syms Middle School provides all students access to, and use of, technology. The emphasis is upon student acquisition of technology skills for the purpose of achieving academic goals.

Individual and group projects provide links to the real-world utility of subjects taught. Access to information allows the synthesis of information, and evaluation of information to determine its relative importance, and allows students to make determinations about the presentation of information. Such environments may foster higher level cognitive skills by encouraging self-directed, creative thought in a structured technology environment. Cooperative projects enable students to participate in, and develop, problem solving and deductive thinking skills. Syms has created a technology-rich educational environment which is designed to provide students learning opportunities not possible in a traditional school. The school uses the technology-rich environment to promote educational activities through the appropriate use of technology.

Cooper Elementary School

Cooper Elementary School, a technology-rich school since 1992, is a school serving 540 kindergarten through 5th-grade students. Assigned staff includes 34 teachers and 15 others, to include administrators, specialists, and clerical and custodial personnel. Cooper is 100% internally networked through a cable system which connects administrative areas, 23 of 26 classrooms (five to ten computers each), and one technology classroom to a Macintosh II/SI central file server. External connectivity is afforded by modems connected to a city mainframe through a dedicated telephone line permitting VA-PEN and Internet access. In addition to networked computers, other technologies in the school include CD-ROMs, VCRs, laserdisc players, camcorders, scanners, printers, N-View projector, and a digital camera.

Student use of, and exposure to, technology. As with all the technology-rich schools, Cooper Elementary's primary goal is to provide its students with a maximum of quality exposure to technology for the purpose of promoting learning. Cooper Elementary School has two primary approaches to increasing student use of, and exposure to, technology: 1) use of computers in classrooms and 2) use of assorted technologies in a technology classroom and library.

Computer use in classrooms. The use of computers in classrooms is the core approach utilized by Cooper Elementary School to increase use and exposure. All classrooms at Cooper have access to computers. Generally, the computers have word processing, graphics, educational games, telecommunications, and spreadsheet software installed. Available software includes Kid-Pix, Storybook Weaver, Pagemaker, ClarisWorks, PowerPoint, Excel, and Writing Center. Teachers use classroom computers 30 to 60 minutes per day for recording student grades, word processing, telecommunication (E-mail), lesson planning, and administrative activities.

However, the focus is on student use of classroom technology. The most frequent uses of classroom computers by students are word processing, special projects, preparation of classroom reports, skills practice (reading, writing, and mathematics), graphic presentations, and playing educational games. For example, students keep track of their grades by using an Excel spreadsheet. Individual students enter their grades into a spreadsheet on a weekly basis and monitor their performance. Students subsequently create graphs and charts of their academic progress. In another activity, students use technology to create talking books. During this process, students, working in pairs, create a synopsis of a book by incorporating sound and by importing text, graphics and videos using Storybook Weaver. The paired students view text and graphic material previously written by classmates and then add narrative, text, and graphics to expand the story. The completed product is a talking book to be shared with classmates. Individual and group projects provide a pattern within Cooper for the use of technology. The projects allow students to explore the uses of technology in a creative and educationally productive manner.

Classes at Cooper Elementary School use technology as a standard approach to education. For example, students tasked to write a report about a unique animal use Grolier's Encyclopedia to gather information and a scanner to digitize pictures of the animal. Finally, the students print a report which incorporates text and pictures.

Cooper Elementary School has used its technology-rich environment to promote a school-business partnership in the commercial graphics business. The City of Hampton commissioned Pete Marwich, Inc. to conduct an impact evaluation concerning the effects of local military downsizing in the Hampton area. Pete Marwich, Inc. gathered information which was given to Cooper Elementary School. Cooper's students created a PowerPoint presentation which included spreadsheets, video clips, and charts. The formal, end-of-study briefing was presented to mayors and city officials of Hampton and Newport News, college presidents, and local business leaders. The three week project allowed students to apply their technology skills to a real-life problem.

Use of technology in a technology classroom and library. The use of the school's technology classroom and library provide students other opportunities for technology exposure and use. The available equipment includes computers, printers, VCR, laserdisc, and CD-ROM players, electronic scanner and facsimile machine, cassette recorders, and access to other equipment as required. Available software includes MacPaint, Number-Maze, Number Muncher, Oregon Trail, ClarisWorks, Writing Center, PowerPoint, Excel, Clip Art, Filemaker Pro, and Writing Center.

The library has books, sound filmstrips, videos, software programs, records, CD-ROMs, and other audio visual and computer products in addition to an on-line library catalog. Available to students eight hours per day, an individual student spends 45 minutes in the library per week. On an average day, the library staff spends 30 minutes working with teachers (e.g., teaching the use of the CD-ROM version of Compton's Encyclopedia or locating specific information for teachers), 15 minutes in planning meetings, 45 minutes preforming administrative duties, and 210 minutes teaching students or assisting students with projects. For example, the library staff teaches and assists students in the use of the on-line catalog, use of filmstrips viewers, use of CD-ROM products, and provides assistance in gathering information for student projects.

Student use and understanding of the library's technology is further expanded by the students assigned to the library. Ten students are selected daily to be library helpers. These students are trained to collect library books, log returned books into the library's computer, and log books out. The student helpers experience real-life applications of technology and learn to work cooperatively with fellow students. The library staff also assists groups of students in the completion of student group projects. Students use the library's electronic systems to research topics and to retrieve and print information for individual assignments.

In addition to the library, Cooper Elementary School has one *technology classroom (TECH class)*. The TECH class is a classroom with extensive technology equipment. During a normal school day, students spend 45 minutes per day engaged in technology activities. The TECH classroom is available six hours per day for individual or group projects. Students use the TECH classroom for a variety of special projects. For example, students use PowerPoint to create presentations for science, English, and social studies topics. Also, HyperCard is used to create electronic field trips.

During a recent visit to Jamestown, students collected information and took pictures. The pictures taken by students, or acquired from other sources, were scanned into a computer. Student text and statistics, along with digitized photographs, were merged into a single document. The finished product was an electronic field trip visit to Jamestown which was presented to classmates using presentation software.

Another example of TECH class use is a distance education music class in which Cooper students participated. Emanating from McIntosh Elementary School, Newport News, Virginia, students at Cooper interactively participated with a teacher who provided instruction in the creation of lyrics and music. Computer software and telephones at Cooper were used by students to interact with the music teacher, while students watched a TV screen.

Summary. Cooper Elementary School is a technology-rich school which provides all students, K-5, with access to computers daily. The educational environment of the elementary school allows the integration of technology and curriculum. Student usage may be three to five hours per day, depending on the event, or day of the week. However, on average, students at Cooper will use classroom technology for 30 minutes to two hours per day. At this educational level, emphasis of technology usage is directed towards technology skills and individual and group projects. Students learn to acquire, organize, synthesize, and evaluate information. The cooperative nature of the elementary classroom fosters individual and group learning. Cooper Elementary School has created a technology-rich educational environment which is designed to provide students expanded learning opportunities.

Summary Technology-Rich Schools

Project-based learning is a standard approach within the technology-rich educational environment. Impact on both the cognitive and affective domains may be accomplished with the curricular design implemented by the technology-rich schools. Students work in a cooperative atmosphere where common knowledge elements are acquired to resolve class-oriented questions, problems, and projects. Baseline facts are learned by students, while new information is fitted to the project framework and reinforced by students and teachers. The distinction is not in the subject matter, but in what happens to the information in so far as the learner is concerned. Under the circumstances of self-discovery, the student acquires information in a process that incorporates larger learning steps than those possible through associative learning. When the student conceptualizes in a project-oriented, self-directed manner, insight is reinforced, and the goal becomes coordinated with that of the course requirements.

Another aspect of the learning environment is intuitive thinking and discovery. The technology-rich environment allows students to access a diversity of information and basic facts. These are required before intuitive learning takes place. Ideas are sometimes formed by a student who is listening and observing while a more vocal student is relaying educational information. Such is the case in the technology-rich environments where students work collectively to complete projects through the use of technology. The cooperative technology-rich environment permits students to absorb information concerning a topic from fellow students.

Student acquisition and evaluation of knowledge is another important facet of the environment. Knowledge is acquired by students through classroom presentations and through research. The information is assimilated and evaluated by the students in the process of creating individual class reports or group projects. The technology-rich environment places a premium on self-acquisition of information and the evaluation of that information for inclusion into reports, projects, and papers. The collective nature of the projects is intended to allow the cross-fertilization of learning among and between students.

Additionally, a student's background is a factor in learning. Some students may be immediately able to participate in a self-directed learning process. However, for others, it may be difficult to participate in such a mode of learning. The technology-rich environment allows accommodation for different student learning styles and rates. Shared information and approaches to projects permit individual learning in a collective educational process. The intent is that students learn in a self-directed mode and through group projects. The teacher's function is to establish the educational environment so that learning styles can be accommodated.

Finally, one of the more important aspects of learning in the technology-rich environment is the transfer of information from one subject area to another. The skills learned in a computer class could be immediately used in an English or social studies class. Commonalities between subjects become more concrete, rather than abstract to students. A report in English requires the same skills as a report in social studies, with common access to data and information. The real-world application of the skills is transferable to a wide variety of educational and employment situations. The realization by students that skills and information are immediately transferable may increase the rate of learning among students, thereby enhancing their motivation. Bethel, Syms, and Cooper are designed to impact students both cognitively and affectively through the opportunities provided by the technology-rich environment.

Research Framework

Significance of the Study

A Nation at Risk (1983) initiated the American educational reform movement with a call for the restructuring of high schools. The Secretary's Commission on Achieving Necessary Skills of the Department of Labor has published volumes promoting new schools to support labor requirements of business and industry. In America 2000, the Department of Education called for the voluntary acceptance and adherence to national educational goals and standards. Noted authors such as Allen in Schools for a New Century: A Conservative Approach to Radical School Reform, 1992, Spring in Conflict of Interest: The Politics of American Education, 1993, and Berube American Presidents and Education, 1991, encourage experimentation, restructuring, and national participation in schools to prepare students for the future.

The infusion of technology into schools is being promoted "more by external forces...[such as] vendors, media, legislators and some educators..." (Pisapia, 1993, p. 1). Additionally, parents, business, and industry are encouraging the implementation of technology in schools. In response to these technology promoters, leaders of educational organizations are utilizing differing approaches in adopting technology. The result is that no single technology model is universally accepted by educational organizations. Accordingly, within educational organizations, the varied array of technology uses has not reached optimum levels of effectiveness (Pisapia, 1993).

Hampton's technology-rich concept may have national implications. Hampton has initiated and implemented a technology-rich school concept which departs from the traditional model, and possibly, may provide a responsive and innovative approach to effective education for future citizens. Given the absence of a national blueprint for tomorrow's schools, Hampton's technology-rich schools could provide such a direction. Although the concept continues to require the allocation of financial, facility, and personnel resources, an examination of the impact of technology-rich schools in a manner implemented by Hampton City Public Schools on the academic achievement and attitudes of students has not been conducted. In recognition of this information gap, this research focused on the impact of technology-rich schools on students. Providing a significant contribution to the body of knowledge on the effectiveness of technology-rich environments was the primary focus of this research.

Research Problem

Public school education is the biggest information-based industry in the United States, yet it is lagging in its ability to provide students with a fitting match between the school environment and the high-tech economic environment (Perelman, 1993). Hampton has committed significant amounts of time, money, space, and people to the maintenance and expansion of technology-rich schools. To date, no formal research has examined the effects of this implementation of technology-rich schools. What is not known is whether technology-rich environments affect student performance and attitude. Accordingly, this research examined the effects of Hampton's technology-rich schools on students' academic achievement and attitudes.

General Hypotheses

The general hypotheses of the study:

1. There is no significant difference on measures of academic achievement between students attending a technology-rich school and students attending a traditional school.

2. There is no significant difference on measures of academic achievement based on gender, computer ownership, and ethnicity between students attending a technology-rich school and students attending a traditional school.

3. There is no significant difference on measures of students' attitudes between students attending a technology-rich school and students attending a traditional school.

4. There is no significant difference on measures of students' attitudes based on gender, computer ownership, and ethnicity between students attending a technology-rich school and students attending a traditional school.

Research Questions

This study examined the differences between selected Hampton technology-rich schools (4th, 6th, and 11th grades) and Hampton traditional schools (4th, 6th, and 11th grades) relative to student academic achievement and students' attitudes toward school, computers, and selves. Specifically, this study investigated the following questions:

1. Do 4th-grade, 6th-grade, and 11th-grade students attending a technology-rich school achieve significantly higher scores on measures of academic achievement than traditional-school students as measured respectively by the IOWA Tests of Basic Skills (ITBS), Virginia Literacy Passport Test (LPT), and Tests of Achievement and Proficiency (TAP)?

2. Do 4th-grade, 6th-grade, and 11th-grade students attending a technology-rich school achieve significantly higher scores on measures of academic achievement than traditional-school students as measured respectively by the IOWA Tests of Basic Skills (ITBS), Virginia Literacy Passport Test (LPT), and Tests of Achievement and Proficiency (TAP) when factors of gender, computer ownership, or ethnicity are considered?

3. Do 4th-grade, 6th-grade, and 11th-grade students attending a technology-rich school have a more positive attitude towards school, technology, or self than students attending a traditional school as measured by an attitude questionnaire administered to students?

4. Do 4th-grade, 6th-grade, and 11th-grade students attending a technology-rich school have a more positive attitude towards school, technology, or self than students attending a traditional school considering factors of gender, computer ownership, or ethnicity as measured by a student questionnaire?

Delimitations

The delimitations of this research are: (a) only Hampton City Schools were examined; (b) the study considered only three Hampton technology-rich schools and three traditional schools; (c) the study was limited to students in the 4th, 6th, and 11th-grades at the selected schools; (d) students were not randomly selected or randomly assigned to treatment or comparison groups; (e) teachers were not randomly assigned to treatment or comparison schools and no attempt was made to control for teacher variables; and (f) the study examined only 1993-1994 school year data.

Chapter 2

Review of the Literature

Introduction

There are many legitimate forms of schooling; however, the ability of each form to achieve the *current* or *projected* societal goals causes controversy. Criticism of traditional schools stems from the perception that public schools have failed to achieve the desired end. The approaches to education which are most widely employed today may fail to accomplish the goal(s) which society deems important (A Nation at Risk, 1983). Sheingold (1991), in her article *Restructuring for Learning With Technology: The Potential for Synergy* emphatically states,

> ...the lockstep approach to learning that is common in most schools (i.e., everyone in the same grade learning the same thing, at the same time, and in the same way) will fail for many students. (p. 19)

An approach is defined by Webster's New Collegiate Dictionary (1977) as "a particular manner of taking preliminary steps toward a particular purpose" (p. 56). The topic of the present discourse considers an approach to teaching and learning and the educational model (a system of assumptions) which is derived from this approach. Educational approaches stem from, and are grounded in, educational philosophies. Although there are many educational philosophies, and they frequently are labeled by a variety of names, it is possible to extract five distinct ones from the array: perennialism, idealism, realism, experimentalism (also known as experientialism), and existentialism. These philosophies range from the most conservative (perennialism) to the most liberal (existentialism). The present research will be viewed through the philosophical filter of experientialism because the characteristics of experiential learning can be traced through the technology-rich environment's approach to teaching and learning (Wiles & Bondi, 1989).

Characteristics of Experiential Learning

The basic characteristics of experiential learning are involvement, relevance, responsibility, and flexibility. Learning is furthered by full involvement of participants and results from engaging in an activity. Involvement can produce active learning which can be motivating and self-reinforcing. "Involvement affects attitude change and growth as well as skill development" (Walter & Marks, 1981, p. 3). Sheingold (1991) refers to the importance of involvement by stating that

> Effective learning hinges on the active engagement of students in constructing their own knowledge and understanding. Such learning is not a solitary process; it occurs through interaction with and support from the world of people and objects and through the use of technologies of many kinds. In this model of learning, teaching involves less telling and more supporting, facilitating, and coaching of students. And learning itself becomes not the acquisition of a stable body of facts and truths, but rather a dynamic process of understanding knowledge and its human creation. (p. 19)

Relevancy is marked by the practical application of learning. Relevancy links information to behavior and fosters pragmatic use. Students who choose the direction and scope of their educational efforts seek activities that they perceive as beneficial. Involvement in class decision-making leads to student perceptions that educational activities are relevant. Learning can also take place through interpersonal exchanges--a central component in everyone's life--used in addressing a topic. Since experiential learning provides opportunities for students to determine the goals of the learning experience, student commitment is reinforced, and students gain a real sense of involvement in their own learning experience.

Thus, the third characteristic of experiential learning comes into play--responsibility. Walter & Marks (1981) state that

> Participants have to choose the amount of energy to invest and how to respond in the activities. Their responses in the learning situation can then be related directly to their choices. If they desire different outcomes, they must behave differently to achieve them. The responsibility for managing this change is solely in their hands. (p. 3)

Finally, flexibility of settings, participants, and types of learning experiences allows for the use of experiential learning in a variety of learning situations for students with widely differing needs (Walter & Marks, 1981, p. 3). Teachers are able to use individual or group projects as vehicles in learning activities. Cooperative groups promote a sense of collective effort in the learning process. Flexibility permits teachers and students to create, adjust, and modify classroom events to increase learning opportunities.

Experiential learning strives to restructure the environment to provide a maximum level of empowerment for both students and teachers. This empowerment enables both parties to give free reign to creativity and uniqueness in their teaching and learning. For example, experiential learning supports open-classrooms and Montessori-type environments where learning occurs through a problem-solving, inquiry, or learning-by-doing format. The technology-rich environments discussed in this study incorporate the basic characteristics of experiential learning; therefore, these characteristics and some of their relevant tangents such as interaction, empowerment, feedback, and self-esteem will be addressed.

The educational approach, and the subsequent model which is generated for teaching and learning, is dependent upon the answers school leaders give to the following questions: "What is education for? What kind of citizens and what kind of a society do we want? What methods of instruction or classroom organization must we provide to produce these desired ends?" (Wiles & Bondi, 1989, p. 43).

What is the purpose of education? In terms of experientialism, the purpose of education is to discover and expand the society in which we live and to share these experiences (Wiles & Bondi, 1989, p.49). The technology-rich environment's main characteristics are to create experiences through technology which expand a student's world and to interact with others in an effort to enhance learning. "As an individual interacts with the people and things around him, he evolves a unique emotional and cognitive makeup. In so doing he alters his ways of dealing with the social and physical environment and his ability to expand his private world" (Wilson, Robeck & Michael, 1974, p. 16).

What kind of citizens and what kind of society do we want? Experiential learning subscribes to the belief that the world and society are continually changing. A citizen who accepts change and is constantly seeking to discover new ways to expand and improve society would be the ideal citizen. The daily environment of today's children has changed and is constantly changing. Strommen & Lincoln (1992) speak to this point.

> ...Our children have been raised in a world of instant access to knowledge, a world where vivid images embody and supplement information formerly presented solely through text. They are used to an environment where they control information flow and access, whether through a video game

controller, remote control, mouse, or touch-tone phone. (p. 1)

In this age of tremendous technological change, a student who can learn to accept change, and practice new ways of dealing with the rapidly changing world is prepared for the future. The technology-rich environment approach seeks to produce students who can deal with rapid change and who are innovative in their problem solving through the use of technology.

What methods of instruction or classroom organization must we provide to produce the desired ends? In the experiential view, the teacher's role is that of an aid or consultant for students. The student's role is active and is based on the premise that learning will occur through the problem-solving, inquiry, or learning-by-doing format. Sheingold (1991) states that "Only through serious involvement with content can students be challenged to reason, question, integrate information from different sources, and devise their own interpretations" (p. 19). The technology-rich approach translates the experiential characteristics into practice by providing maximum flexibility and empowerment to teachers and students; providing serious involvement with content, feedback, interaction, and relevant real-world experiences; establishing a learning-by-doing or hands-on approach to instruction; and instilling positive self-esteem and a sense of responsibility for their own learning in students.

Based on the characteristics of experiential learning approach (i.e., *involvement*, *relevancy*, *responsibility*, and *flexibility*), this review of literature focuses on the impacts of technology on students as learners. Specifically, studies which deal with student achievement and/or attitudes in technological learning settings are targeted. The studies examined represent micro-environments which employ technology as an instructional medium. Also, since the nature of technology changes rapidly, research older than 1987 was avoided. Valid insights into today's technology-rich educational environments could hardly be gained from research investigating the use of Wang computers, mainframe-linked dumb terminals, key-punch cards, or magnetic (MAG) card typewriters--1983 vintage. The importance of the cited studies is in the findings about self-enhancing elements such as student involvement, learning by doing, content relevance, student responsibility, empowerment, feedback, interaction, information sharing, self-monitoring, motivation, program flexibility, real-world experiences, heightened self-esteem, and increased academic achievement which are the touchstones for the research presented.

Technology has a significant place in today's world and has an even greater role in tomorrow's world. However, the emergence of technology in American schools has given rise to discussions within the educational community. At all levels of education, the application of technology has gradually gained acceptance as a part of the educational mainstream. Yet questions remain, particularly those which concern the impact of technology on academic achievement and student attitudes.

Technology and Academic Achievement

The experiential learning approach focuses on learning resulting from student involvement, relevance of work, student responsibility for learning, and flexibility of application. The experiential approach fosters the use of assets to encourage student-directed learning in environments of creativity and innovation (Walter and Marks, 1981). Proponents of the experiential approach see the use of technology and technology-based environments as being substantially beneficial to student-centered learning.

> Heavy-duty computer resources are also making themselves felt. These include word processors, computer programming environments such as Logo, spreadsheets, computer-aided

> drawing systems, databases--and, of course, special-purpose tutorial environments for cultivating particular skills: sometimes routine such as arithmetic operations, and sometime not so routine, such as aspects of higher-order thinking. (Perkins, 1992, p. 138).

The early promise was that integrating computers into the classroom would improve students' academic achievement. Computer-assisted instruction (CAI) would aid students of varying abilities. Students would receive current information and exposure to learning opportunities not possible in the traditional classroom. Furthermore, computers would provide remediation opportunities and enhancement of individualized learning. As reported by Bean and Lipka (1984) about a comparison study between experiential-group students and control-group students,

> ...graduates of experiential programs demonstrated the following characteristics relative to graduates of the control settings:
>
> 1. A higher degree of intellectual curiosity and drive
> 2. More clear and well-formulated ideas concerning the meaning of education
> 3. A higher degree of resourcefulness in meeting new situations
> 4. Greater effectiveness in approaching adjustment problems... (p. 102)

The experiential technology-based approach provides for the involvement and creativity of teachers and students, but it is "...important to realize that [learning] opportunities afforded by innovations often bring with them a bewildering array of new things. A word processor, for example, does not await attentively for you to tell it what to write" (Perkins, p. 146). Experiential technology-based teachers face *normal* salient student issues (e.g., student social and physical development), and additional issues concerning the application of technology. There are issues regarding the effect of computer use on cognitive growth (achievement), the utility of technology in specific subject areas, the impact of technology use on student-student and student-teacher interaction, and the flexibility of technology to equally meet the developmental requirements of males and females. Technology may offer learning opportunities, but "...innovation commonly cannot be reorganized by novices. ...[and] students commonly run headlong into considerable confusion and disorientation" (Perkins, p. 146).

Computer use. Computers in classrooms, school laboratories, and at home permit student use of technology. The technology-rich environment engages students in authentic and legitimate work which has a connection to the world at-large. This relates to the relevancy characteristic of experiential learning. As stated by Sheingold (1991), "Authentic and legitimate work, work that has real connection to the world outside school, is likely to be engaging and memorable precisely because it does matter" (p. 19). Because what is learned is relevant and memorable, the knowledge tends to be reflected in higher academic achievement.

The research suggests that extended use of computers resulted in increased student academic achievement (Salerno, 1993; Din, 1994). Other studies indicate that home computer ownership is positively correlated to improvement in students' academic achievement (Cates, 1992; Nichols, 1992). Everhart (1992) concluded that students who participated in a computer lending program, a version of home computer ownership, improved their class grades. Liston (1991) investigated a CAI remedial reading instruction model and noted that there was an increase in reading achievement for those students using CAI and attending a computer laboratory. The findings of Robert, Kieffer, Stowell, Desai, Whalin, and Moss (1992) suggest that students who have had unlimited access to technology and computers experienced academic gains. Robert, et al, report:

> ...at the end of year two, all students perceived an improvement in their ability to write as a result of using the computer. By year four, their strategies had shifted toward the inclusion of graphics to either complement or spur the development of their text. (p. 5)

Computer use is a central theme in technology-based experiential educational environments. As noted, previous research supports the hypothesis that availability of computers enables students to use and to be exposed to technology in a variety of forms, and in so doing, impacts student achievement in a positive manner. Computer use, in the studies cited, promoted increases in academic achievement. In a micro-sense, these studies suggest that educational approaches which use technology may produce a wide range of impacts on academic achievement.

Gender. Classroom teachers strive to provide learning experiences to male and female students equally. However, boys and girls are different in psychological and physical composition. The significantly different social gender roles of boys and girls at all age levels and the impact of those roles on student learning is addressed by Ausubel (1968).

> It is not only that most elementary-school teachers are women, but also that feminine values prevail in the school with respect to what is taught and the kind of behavior that is expected and approved: propriety, obedience, decorum, cleanliness, tidiness, submissiveness, modesty, paying attention to what one is told, remembering, facility in handling verbal symbols, and the control of fidgetiness, curiosity, and aggressiveness. In terms of cultural expectations and peer group norms, success in school is much

> more appropriate for the female than for the male sex role in elementary and junior high school. ...in middle adolescence, however cultural expectations change radically. Academic achievement becomes a more acceptable male virtue and, accordingly, the achievement gap between boys and girls begins to close. Boys with low intrinsic self-esteem and high anxiety seek more than do their female counterparts to find compensatory ego-enhancement and anxiety reduction in school achievement.... (p. 434)

The experiential teacher employing technology strives to actively involve all students in the learning process. The relationship between computer usage and gender provides valuable insight into the impact of utilization. Salerno (1993) reports that female computer users had higher mathematic achievement scores than those engaged in traditional workbook activities. Leali's (1993) findings suggest that males had a more positive attitude toward computers than females. Reagan (1992) suggests that CAI in business mathematics affected male and female students' achievement scores equally. Lu (1994) reports that the use of CAI in biology classes has a more positive impact on the academic achievement of female students than male students. The literature suggests that there are differential achievement effects of computer usage with regard to gender. The hands-on, self-directed approach to learning indicated in these studies may have had an impact on the gender-related findings. Although the findings are mixed for isolated classroom situations, a school-wide culture of technology may mitigate gender as a factor in academic achievement.

Interaction. Active involvement of students in the process of learning is the first characteristic of experiential learning. Involvement is fostered through interaction. Student-teacher and student-student interactions significantly modify the traditional role of the teacher as the giver of knowledge. One concern is that technology may eliminate or reduce student-teacher interface. However, in the experiential learning environment, the student-teacher interaction is a critical component. Teachers foster acceptable choices as students direct and accept responsibility for their learning and actively participate in the creation of a flexible learning environment. Beane and Lipka (1984) state that

> The availability of such technological devices should offer schools increasing opportunities to focus on affective education. Through the use of television, telephones, cassette recorders, and home computers, knowledge dissemination can be carried out in the home, at school, while traveling, or virtually anytime, and without the physical presence of a teacher. Thus teacher time and school facilities may be freed to focus on interaction, interpersonal communications, problem solving, and personal/social development. (p. 194)

In comparison to the traditional approach, student-student interaction is adjusted in the experiential learning approach. Students accept responsibility for learning events and the accomplishment of tasks. Peer teaching and cooperative groups increases student-student interaction and reliance. Students receive appropriate guidance from the teacher, but are quickly released to accomplish the learning task in a self-directed manner. The infusion of technology into the cooperative group does not reduce or eliminate student-student interaction (Perkins, 1992). Cooperative group environments fostered by the experiential learning approach, provide longterm benefits to students.

> ...students consistently engaged in cooperative learning arrangements have
>
> 1. A higher motivation to learn

2. Greater intrinsic motivation

3. Shown improvement for both tutor and tutee

4. Demonstrated more positive perceptions about the intentions of others

5. Displayed a decrease in negative competition

6. Shown a greater acceptance of differences in their peers

7. More positive perceptions about the intentions of others

8. Shown improvement in their attitude to persons of different races

9. Displayed greater self-sufficiency and a decrease in dependence on the teacher (Irvin, 1992, p. 316)

Teachers using the experiential learning approach and employing technology promote the active student participation in the learning process. The relationship between computer usage and student-teacher and student-student interaction are important factors in academic achievement. Shutrump's (1993) findings suggest that teacher-student interaction was a significant predictor of academic achievement regardless of instructional approach. In similar studies, Bishop (1994) and Thayer (1992) also report that individualized teacher instruction was more important than the instructional technique in producing an effect on academic achievement. Additionally, student-student interaction was a contributor to increasing academic achievement. The results of the study by Leali (1993) suggest that students who were taught mathematics in a cooperative group using CAI preformed better than students in an individual-based CAI class. Bradley (1993) sought to identify the differences in student-teacher interactions and method of instruction. Bradley's findings indicate laboratory computer teachers provided more individual explanation to students and monitored students' academic progress more closely than classroom teachers. Technology, effectively employed by teachers, enhances the interaction between teacher and student. These studies suggest that the use of technology does not replace the requirement for effective teachers. Rather, they suggest that technology educational environments may experience a different form of student-teacher and student-student interaction. The positive interactions with others, including the teacher, using the experiential approach change the students perception and understanding of themselves and the world around them. The positive alteration of perception in turn allows additional growth to occur.

Subject areas. The experiential learning approach fosters student directed activities and responsibilities for work accomplishment. Sheingold (1991) states that "...classrooms will have to become places where all students can be deeply engaged in learning subject matter. Learning to think and learning content are integrally related" (p. 19). In a technology-based experiential learning setting students use the school's technology to accomplish individual or collective tasks. In the experiential environment the impact of computer-based technology on students' academic achievement in specific subject areas is a topic of research. Students experienced gains in mathematics achievement through the use of CAI (Dowdney, 1987; Sasser, 1990; Pike, 1991; Reagan, 1992; Wong, 1993; Clayton, 1993). The measures of achievement in mathematics included national, state, and local tests. In science, Morse's (1991) findings suggest that CAI increased academic achievement and increased scientific reasoning skills. Rieber (1990) determined that animated graphic programs which taught Newton's laws of motion as drill and practice enhanced learning. Lu (1994) reports that CAI in biology increased academic achievement among students who were below the class median. Peterson and Williams (1990), Pitre (1993), and Clayton (1993) found increases in students' reading achievement scores when using CAI. Liston (1991) investigated a CAI remedial reading instruction model and compared it to the traditional reading remediation model. Liston found that reading achievement increased in the second year for the CAI group.

However, computer applications may go beyond core-curriculum academic subjects. One of the attractive features of technology is the flexibility of hardware and advanced software which can provide helpful learning experiences. Kassner (1993) conducted a study using CAI in music with beginning band students. The findings suggest that students spent more time-on-task, found the CAI in music easy to use, and expressed a desire to repeat the usage of the CAI in music. Additionally, the study found there was a reduction in band student attrition rates. Petri (1993) reports that CAI in health (AIDS awareness class) resulted in significant increases in AIDS knowledge across the four groups of ninth and tenth grade subjects. CAI also influenced students' perceptions of susceptibility to HIV/AIDS. A study by Schick (1993) focusing on language concepts and vocabulary found that CAI (in this case interactive video) was an effective medium for linguistic instruction.

Some research approaches the study of technology in a wider arena than one subject area. These studies examined the overall effect of technology based on academic achievement in mathematics, reading, and language arts. Kitabchi (1987), Swan (1989), Sinkis (1993), and Roy (1993) report gains in academic achievement in mathematics, reading, and language arts as a result of CAI. Swan (1989) also found that students in the lower grades tended to show greater academic gains than students in the upper grades. Solomon (1990) reports that performance increased in all major subject areas with CAI use. Empirical evidence suggests that the application of technology hardware and software to a variety of subject areas results in a positive impact on students' academic achievement.

Meta-analysis research indicates broad support for the effect of technology on academic achievement and attitudes of students. Research by Cunningham (1989), Roblyer (1989), Lee (1990), Schramm (1990), Ryan (1991), Liao (1991), Armstrong (1992), Gordon (1992), Ouyang (1993), and Atkinson (1994) report various effect sizes ranging from .29 to .55 indicating that computer-based instruction affected students' academic achievement positively.

Technology, as an instructional medium, provides the key element of flexibility to the educational environment. The range of grade levels, subject areas, and the manner in which technology can be used (as indicated by the studies cited) attests to the flexibility of technology. Since the experiential approach is dynamic in nature and acknowledges the ranges of human diversity, a flexible instructional medium is a necessity for learning to take place. This is not to say that flexibility is the only factor at play when technology and learning are involved. However, research indicates positive impacts on academic achievement and attitude, and flexibility appears to be an important component in producing the results.

<u>Summary.</u> What has come to light in the literature reviewed is that effectively applied, educational technologies can impact academic achievement. Although the studies cited do not reflect studies as comprehensive in scope as the present study, they do indicate that consistent rates of impact vary from application to application and program to program. Some educational applications of technology have shown excellent results. Other factors involved are the type of material presented, the level of material, gender, computer access, and teacher interaction. These factors are determinants of effectiveness, as measured by academic achievement. The cited studies in the aggregate indicate that the expansion of technology to an entire school may cause substantial change. Changing the traditional approach to education to the experiential approach fosters the freedom to modify and adjust curriculum, course work, and teaching methods. This is particularly true when the change involves technology. Technology environments which

provide freedom of access to computer hardware and software afford students and staff a variety of educational options which increase the potential for academic success.

Technology and Students' Attitudes

The experiential learning approach fosters and promotes students' active involvement in the process of education, while allowing students to accept responsibility for learning. The relevancy of the study material is perhaps the central responsibility of the teacher, but the process, techniques, and methods employed to learn the material are becoming the students' responsibility. Involvement affects attitude change and growth as well as skill development.

> ...Active learning can be motivating and self-reinforcing. ...Insights are also gained from the interpersonal exchange involved in addressing a topic since relationships are a central component in everyone's life. Participants consistently report an appreciation of the personal significance of this component of their learning. (Walters and Marks, 1981, p. 3)

Student empowerment is fostered by the student-directed nature of the experiential learning approach. Feedback from teacher-student and student-student interface, along with individual and group reliance, promotes individual self-esteem. Accordingly, students' attitudes and perceptions are a central theme of the experiential learning approach. Constructs of self-perception by Beane and Lipka (1984) provide insight into the attitudinal dimension of student learning,

> ...Construct 10. Self-perceptions are most likely enhanced when individuals knowingly assume responsibility for their own learning. Activities in which learners assume greater responsibility and in which they are aware of personal

> efforts in this regard add to personal meaning and satisfaction.
>
> Construct 12. Self-perceptions are most likely to be enhanced when high priority is placed on interaction. Those learning situations in which individuals have opportunities to try out new roles, test ideas, and get feedback from others are most congruent with the interactive nature of self-perception development.
>
> Construct 14. Self-perceptions of ability are multidimensional and hierarchical. Confidence in the ability to succeed may depend on what is to be learned as it relates to the previous experience in the same area of learning. The degree to which individuals perceive that area of learning to be personally salient influences the desire to succeed and interest in the area. (p. 93)

Given the constructs regarding the self-perception of students, students' attitudes and perceptions are an important factor in academic success. Research indicates that many educators perceive a beneficial impact on the affective and cognitive domain of students.

The Wirthlin Group (1989) conducted a nationwide survey of K-12 level teachers' attitudes towards computer usage and the motivational effects of computers on students. The Wirthlin Group reported the following:

> ...82% said that using computers had increased their students' motivation for learning. ...74% overall, felt that students who were not computer literate would not be adequately prepared for college. ...87% of the teachers polled believed that the use of computers helped students develop greater self-confidence. ...87% of the teachers polled believed that the use of computers could help them

> (teachers) unlock the creative potential of students. (p. 31)

Becker (1986), in reporting the results of a survey of over 8,000 principals and teachers, determined that educators who employed computers

> ...saw significant benefits occurring mainly in four areas: student motivation, student cooperation and independence, opportunities for high-ability students in programming activities and in other high-order thinking and writing skills, and opportunities for low-ability students to master basic math and language arts skills. (p. 2)

Rockman (1993) maintains that CAI researchers need to examine both student attitudes and test scores. Although immediate answers may not be forthcoming, Rockman suggests addressing the following issues: 1) student attitude changes towards learning, and 2) the development of students' willingness to learn on their own. These two issues are key points in the experiential learning model. Of particular importance to the experiential teacher are student empowerment provided by technology, acceptability of student feedback, and development of student self-esteem. Studies provide evidence of technology-based educational practices with a focus toward student empowerment, feedback, and self-esteem.

Empowerment. The experiential approach encourages students to be actively involved in the process of learning and to accept responsibility for learning. Far from the traditional model of education with the teacher as the gatekeeper of knowledge, the experiential approach empowers students to accept responsibility for decision-making and learning. As Strommen & Lincoln (1992) stated, "They [children] are used to an environment where they control information flow and access..." (p. 1). Irvin (1992) states, "...students need practice, under supervised conditions, to make choices, select from alternatives, and assert their own personalities" (p. 290). The experiential approach provides students with levels of empowerment as a means of acquiring knowledge and understanding. Accordingly, students participate in class planning efforts that relate to learning activities to be conducted either individually or in a cooperative group setting.

> This kind of deliberation gives individuals a chance to think about their own interests and ideas; in other words, to determine the relationship between the unit topic and salient dimensions of the self. In addition, learners may feel a sense of control over that portion of their lives that will be devoted to the unit. As the teacher takes student ideas seriously and ideas become actual objectives and activities, he or she is suggesting an expectation that students are capable of and responsible in making decisions--that student ideas count for something. (Beane and Lipka, 1984, p. 117)

"Intrinsic motivation in particular can be boosted by giving students more choice about exactly what they work on and more information sources than teacher and text..." (Perkins, 1992, p. 165). Technology offers a unique approach to involving students in their own educational process and providing a sense of environmental control--empowerment. Student empowerment through the use of technology is essential and, therefore, is a topic of ongoing research. Swan (1990) suggests that CAI may change the locus of control; for example, when students believed they were in control of the learning process, they became active participants. Al-Eisa (1994) expanded on Swan's finding and found that high-ability students made greater gains in academic achievement than low-ability students when provided options of maximum control over the CAI directed lesson.

Fisher (1988) examined student empowerment (internal locus of control) as a factor of high-computer access and defined student empowerment as a condition in which students recognized themselves as being responsible for controlling their own learning. Fisher's findings suggest that students had feelings of increased empowerment when they had high computer access, had the discretion of determining task size and complexity, and received related feedback. In a similar study by Cordova (1994), the findings suggest that students found CAI intrinsically interesting. Cordova also reported increased academic achievement and the development of a preference for more challenging problems when the CAI activity was presented in a choice context. Students' perceptions of control over the learning process were found to be a factor in academic achievement.

In a study by Schick (1993), the findings suggest that student control was an important consideration impacting achievement and attitude. As indicated by the literature, technology, through its empowering effect, impacts student attitudes. Giving more control to students for directing their own learning has important implications for the application of teaching strategies. As indicated in the cited studies, the use of technology by teachers and students creates a foundation for a sense of freedom and flexibility in learning activities. Technology-rich educational environments provide an infrastructure for development of student potential.

Feedback. The experiential learning approach is dependent on the coaching and mentorship skills of the teacher. Rather than just a provider of information, the teacher is required to provide motivation and direction to students. The attitudinal impact of learning is influenced by student-teacher and student-student feedback.

> It [feedback] confirms appropriate meanings and associations, corrects errors, clarifies misconceptions, and indicates the relative adequacy with which different portions of the learning task have been mastered. Thus, as a result of the feedback he receives, the subject's confidence in the validity of his learning products is increased, his learnings are consolidated, and he is also better able selectively to focus his efforts and attention on those aspects of the task requiring further refinement. (Ausubel, 1968, p. 316)

Additionally, Beane and Lipka (1984) state that

> Self-perceptions are largely influenced by the environment and particularly by feedback received from others. One consistent source of feedback for students is teacher reaction to their work. ...students develop concepts of themselves based on this feedback and thus may come to accept it as personally appropriate. (p. 132)

In the experiential educational environment, technology may contribute to efforts for providing acceptable performance feedback in a positive manner. One capability of computers is providing immediate performance feedback. Hardware and software are key elements in providing an extensive range of options in the presentation of educational material, thus increasing students' perceived control. Specially created software designed to meet specific educational requirements is an important feature of technology which also enhances feedback. This feedback, intended to stimulate students to learn the material presented, allows the learning process to be productive and enjoyable. An understanding of how a technology-rich educational environment (which provides almost immediate feed-back) affects students could generate applications for regular education students, as well as for students who have learning difficulties.

Brown (1993) reports that students' ego orientation correlated with a belief that students felt they could improve their ability on assigned tasks based on computer feedback. Dowdney (1987), Dehn (1992), and Seidenfeld (1992) concluded that the computer's capability to provide feedback was a positive motivator to students.

Burt (1994) investigated the perceptions of gifted elementary students relative to the motivating factors of computer software environments. He concludes that the most important software features were characterized by arousal of curiosity (both sensory and cognitive), levels of difficulty (challenging), self-esteem enhancing feedback, student control over choice of activities, presence of a fantasy environment, and the availability of game formats. Burt also found that experienced computer users expected sophisticated visual effects, speedy processing (machine and program), and enjoyment.

Self-esteem. Experiential learning requires a student-centered approach to learning, and the technology-rich environment provides such an approach. Students actively contribute to decision-making efforts and work in cooperative groups. "What we used to term hands-on learning has been broadened in concept to include relevant experiences, completed in heterogeneous groups, utilizing cooperative learning strategies" (Irvin, 1992, p. 290).

> ...teaching-learning situations in which this technique is used are democratic, open, and humanistic. The kind of setting in which proposed objectives obviously show a concern for self-perceptions and in which student ideas are seriously considered, is the kind that offers a real chance

> for the enhancement of self-concept, self-esteem, and values. (Beane and Lipka, 1984, p. 117)

Central to the experiential approach is the regard for the self-esteem of individual students. A student's self-esteem impacts the motivation to learn and to contribute. Irvin (1992) states, "Motivating them [students]... will provide substantial evidence of cognitive growth and affective maturity" (p. 291). The utilization of technology in educational setting and its impact on self-esteem has been a topic of research. Khalil (1993) investigated the possibility of differences among three levels of rehabilitation relative to a person's locus of control, self-esteem, and perception of self efficacy. Khalil's findings suggest a trend toward scoring higher on measures (scales) of locus of control, self-esteem, and social self-efficacy for students who used CAI. Lwo's (1992) research found that subjects stated they were more serious and task-oriented when using the interactive CAI. Reagan (1992) indicates that computer-based simulation, as a form of instruction, results in students believing that the computer was useful in society and relevant to instruction. Dahn's (1992) findings suggest that an integrated learning system and the use of CAI resulted in positive student attitudes as noted by students, teachers, and parents.

In an evaluation of five studies, Cheney (1990) provides a summary of the impact of computer technology as a reinforcer for the modification of student behavior. Cheney summarized the findings in the following manner:

> ...Each of the studies reviewed indicates that access to computers can be a potent reinforcer for students with behavior disorders....the appeal of the computer is largely dependent on the quality of the software, it remains to be seen what types of software are the most effective as reinforcers. (p. 54)

Positive experiences that are self-enhancing, such as those described in the attitude research, are a hallmark of the experiential approach. These experiences accordingly affect perception which affects attitude and in turn affects behavior and achievement. As stated by Irvin (1992), "Educators seem to dislike our perceived competition with the media and technological extravaganzas. However, reality is that we are educating a media generation who is used to high-tech, rapid change and stimulating experiences" (p. 290). Technology usage shows evidence of affecting attitude and thus learning behavior, which is the basic intent of education.

Summary

Empirical evidence suggests that computer technology affects student academic achievement and attitudes. The size and direction of the effect depend largely on the application (software), the presentation (teaching method), and the grade of the student. Access, gender, interaction, and subject area are important aspects associated with the degree of academic achievement. Empowerment, feedback, and self-esteem are elements related to student attitudes involved in computer usage. In all of its aspects, technology is a productive educational tool which fosters positive achievement and attitude.

One of the keys to the attainment of positive attitudes is the practical application of technology. The application of technology skills to real-world endeavors seems to be contributing to positive student attitudes and is increasing academic achievement. All of these elements blend to create an experiential learning approach which can allow unbound student development.

Today, multitudes of technology-based products are entering schools. The methods, techniques, and processes by which educational organizations employ technology does not appear to be systematic.

Meanwhile, most research has focused on an individual classes rather than entire schools. Whether a specific technology-rich environment produces increased student academic and attitudinal outcomes is largely unexplored. As Sheingold (1991) states, "...it is not the features of the technology alone, but rather the ways in which those features are used in human environments, that shape its impact" (p. 18).

Chapter 3
Research Methodology and Procedures

Methodology

This study sought to determine if differences existed between selected technology-rich schools (4th, 6th, and 11th-grades) and traditional schools (4th, 6th, and 11th-grades) relative to student academic achievement and students' attitudes toward school, computers, and selves. The six Hampton schools participating in this study were selected and matched based on equivalency of pre-treatment academic achievement (entry level academic achievement) and demographic composition of the sample. One technology-rich high school (Bethel High School) was matched with one traditional high school (Kecoughtan High School), one technology-rich middle school (Syms Middle School) was matched with one traditional middle school (Davis Middle School), and one technology-rich elementary school (Cooper Elementary School) was matched with one traditional elementary school (Cary Elementary School). The technology-rich schools were the treatment group, while the traditional schools were the comparison group.

Equivalency of Groups

Initially three Hampton technology-rich schools were selected for participation in this study (one high school, one middle school, and one elementary school). In agreement with Hampton's Research Committee, three demographically comparable Hampton traditional schools were selected to form the comparison groups (one high school, one middle school, and one elementary school). Table 3.1 presents demographic data of the sample and schools. Equivalency of groups was established by using historical test data. A series of two-tailed *t*-tests examined student's IOWA Tests of Basic Skills (ITBS) standard scores (hereafter referred to as *entry level scores*) for significant differences. The groups participating in this research were those who (during school year 1993-1994) were 11th-grade students at Bethel High School or Kecoughtan High School, 6th-grade students at Syms Middle School or Davis Middle School, and 4th-grade students at Cooper Elementary School or Cary Elementary School. For the high school samples, historical data (8th-grade ITBS scores) were used to establish equivalency of the 11th-grade students at the technology-rich high school and the traditional high school. The composite 8th-grade ITBS scores represented high school entry level scores for 11th-grade students at Kecoughtan High School and Bethel High School. Students in the 6th-grade entered a technology-rich middle school or traditional middle school from elementary school with 5th-grade ITBS scores. The 5th-grade ITBS scores represented middle school entry level scores for 6th-grade students at Davis Middle School and Syms Middle School. Students in the 4th-grade completed an ITBS examination in 2nd-grade. The 2nd-grade ITBS scores represented entry level scores for 4th-grade students at Cary Elementary School and Cooper Elementary School. Table 3.2 provides the results of a $\underline{t}$-test examination of pre-treatment, entry level academic achievement scores.

As presented in Table 3.2, the results of $\underline{t}$-test analysis ($\underline{p} = .01$) revealed no significant differences in entry level ITBS scores between 11th-grade students attending Bethel High School and Kecoughtan High School ($\underline{p} > 0.01$), between 6th-grade students attending Syms Middle School and Davis Middle School ($\underline{p} > 0.01$), and between 4th-grade students attending Cooper Elementary School and Cary Elementary School ($\underline{p} > 0.01$). Therefore, upon entry to their respective schools, the treatment and comparison groups were equivalent and comparable.

Table 3.1

Demographic School Matrix

	Elementary		Middle		High	
	Cooper	Cary	Syms	Davis	Bethel	Kecoughtan
Sample[a] n=	(47)	(42)	(337)	(244)	(238)	(170)
Male	14	23	175	107	101	79
Female	33	19	162	137	137	91
Black	31	22	126	114	119	61
Caucasian	16	20	211	130	119	109
Special Ed.	7	5	12	11	4	5
Free Lunch	16	25	87	36	11	19
Reduced Lunch	5	3	33	20	15	3
School						
Over Age[b]	6	7	--	--	--	--
Fitness[c]	80	92	84	84	86	80
Attendance[d]	75	68	72	66	58	56
Lunch[e]	40	49	33	25	10	18
Dropout[f]	--	--	--	--	4	6

Note. [a] Based on research sample.

[b] Percent of 4th-grade students who were 11 or more years of age (1992-1993).

[c] Percent of students enrolled in Physical Education who took all four spring physical fitness tests (1992-1993).

[d] Percent of students who were absent 10 days or less (1992-1993).

[e] Percent of students eligible for free or reduced lunch (1992-1993).

[f] Percent of students in grade 9-12 who dropout of school (1992-1993).

Table 3.2

Examination of Pre-treatment, Entry Level Academic Achievement Scores

	n	Mean	Variance	df	t Value
Bethel	290	169.158	347.407		
				516	2.270[a]
Kecoughtan	250	172.928	389.745		
Syms	415	135.865	184.160		
				701	1.808[b]
Davis	316	134.107	158.089		
Cooper	55	92.290	184.160		
				105	0.911[c]
Cary	53	90.396	107.089		

Note. Two-tailed *t*-test analysis conducted (alpha = 0.01) on student entry level ITBS standard scores.

[a] *t* critical = 2.585; [b] *t* critical = 2.582; [c] *t* critical = 2.623

Instruments

This study employed three measures of student academic achievement and one measure of attitude. During the 1993-1994 school year, students completed standardized tests based upon their grade level. Students in the 4th-grade, 6th-grade, and 11th-grade of the treatment and comparison schools completed the student attitude questionnaire.

IOWA Tests of Basic Skills (ITBS). The ITBS is a nationally recognized standardized test of academic achievement. The ITBS is comprised of a battery of assessments in the areas of vocabulary, reading comprehension, work study, language skills, mathematics, social studies and science. The assessments are generally multiple-choice and have time limitations. The ITBS was completed by 4th-grade students in Hampton City Schools during March/April 1994. The composite standard scores of 4th-grade students in the sample were the dependent measures of academic achievement in this research. Information concerning the ITBS is provided in Appendix A.

Virginia Literacy Passport Test (LPT). The LPT is a Commonwealth of Virginia standardized test comprised of three sections addressing reading, writing, and mathematics. Students are required to pass all three sections of the LPT with a score of 250 or better on each section to earn a high school diploma. Students' scores on each section of the LPT are independent of each other. If they fail to score better than 250 on any section, they must re-take only the failed section.

Reading, writing, and mathematic scores were summed to create LPT composite scores for each 6th-grade student in the sample. The LPT composite scores were the dependent measures of academic achievement. The LPT was completed by 6th-grade students in Hampton City Schools during spring of 1994. Information concerning the LPT is provided in Appendix B.

Tests of Achievement and Proficiency (TAP). The TAP is a nationally recognized standardized test of academic achievement. The TAP is comprised of a battery of assessments in the areas of reading comprehension, written expression, mathematics, social studies, sources of information, and science. The assessments are generally multiple-choice and have time limitations. The TAP was completed by 11th-grade students in Hampton City Schools during March/April 1994. The composite standard scores of 11th-grade students in the sample were the dependent measures of academic achievement in this research. Information concerning the TAP is provided in Appendix A.

Student attitude questionnaire. Educational psychometrists from the Newport News School District provided the student attitude questionnaire based on the Coopersmith Self-Esteem Inventory and their professional experience in the field of psychometry. The questionnaire gathered information about students' attitudes towards school, computers, and self. The questionnaire was administered to 4th-grade, 6th-grade, and 11th-grade students at the treatment and comparison schools. The questionnaire's composite score and three sub-component scores were the dependent measures of students' attitudes in this research. A copy of the student attitude questionnaire and instructions are provided in Appendix C. Table 3.3 provides reliability and validity data for each instrument.

Faculty survey of technology-rich schools. To gather information about the configuration and use of technology within the technology-rich schools participating in this study, a survey of schools was conducted followed by selected interviews. The survey was designed to gather information from teachers and administrators about student use of, and exposure to, technology. Upon completion of the survey, selected interviews of teachers and administrators were conducted to clarify and expand the input provided. The information gathered contributed to the description of students' use and availability of technology at each of the participating technology-rich schools.

Variables

The primary independent variable for this study was the type of school (technology-rich school vs. traditional school), with additional independent variables of home computer ownership, gender, and ethnicity. The dependent variables for this study were students' academic achievement as measured by the IOWA Tests of Basic Skills (ITBS), Virginia Literacy Passport Test (LPT), or Tests of Achievement and Proficiency (TAP), and students' attitudes towards school, technology, and self as measured by the student questionnaire.

Table 3.3

Instruments: Reliability and Validity Data

Instrument	Reliability	Validity
IOWA Tests of Basic Skills (ITBS)	.97[a]	The Commonwealth of Virginia and Hampton City Schools use the ITBS as valid measure of academic achievement.
Literacy Passport Test (LPT)		The Virginia Department of Education determined the LPT to be a valid measure of Virginia's standards of learning (SOL).
Reading	.93 to .97[b]	
Writing	.61 to .97[b]	
Mathematics	.93[b]	
Tests of Achievement Proficiency (TAP)	.82 to .90[c]	The Commonwealth of Virginia and and Hampton City Schools use the ITBS as valid measure of academic achievement.
Student questionnaire	.75 to .93[d]	Educational psychometrists, Newport News School District, the Director of Technology, Hampton City Schools, and the Research Committee of Hampton City School determined the questionnaire to be a valid measure of attitudes.

Note. [a] The ITBS, Level 10, grade 4 reliability coefficient for the composite score based on the adjusted national sample (University of Iowa, p. 100).

[b] Virginia Department of Education, 1992

[c] Mental Measurements Yearbook, p. 862

[d] Based on a pilot study

Table 3.4

Research Design Matrix for Academic Achievement and Attitude

School	Design[b]	Dependent Variables	
		Achievement	Attitudes
Cooper Elementary[a]	- X O	ITBS	Questionnaire
Cary Elementary	- - O	ITBS	Questionnaire
Syms Middle[a]	- X O	LPT	Questionnaire
Davis Middle	- - O	LPT	Questionnaire
Bethel High[a]	- X O	TAP	Questionnaire
Kecoughtan High	- - O	TAP	Questionnaire

Note. [a] Hampton City Schools technology-rich educational environments.
[b] Design compares schools based on the indicated dependent variables.

Design

A quasi-experimental design was employed and comprised of three treatment and comparison groups--11th-grade students from two comparable schools, 6th-grade students from two comparable schools, and 4th-grade students from two comparable schools. Random selection or assignment of students was not possible in this research. Schools were matched based on demographic and academic factors. Table 3.4 depicts the research design employed in this study.

Procedures

Student Academic Achievement

ITBS data were obtained from school records for 4th-grade students enrolled at Cooper Elementary School (n= 60) and Cary Elementary School (n = 54). LPT data were obtained from school records for 6th-grade students enrolled at Syms Middle School (n = 424) and Davis Middle School (n = 385). TAP data were obtained from school records for 11th-grade students enrolled at Bethel High School (n = 354) and Kecoughtan High School (n = 317). All records were from the 1993-1994 school year.

Student Attitude

A student attitude questionnaire was administered independent of other dependent measures in this study. Students in the 4th-grade at Cooper Elementary School (n = 62) and Cary Elementary School (n = 56), 6th-grade Syms Middle School (n = 420) and Davis Middle School (n = 358), and 11th-grade Bethel High School (n = 349) and Kecoughtan High School (n = 243) of the treatment and comparison schools responded to the questionnaire. First-period teachers of the participating schools received the questionnaires, teacher instructions, and students' response sheets, and administered the questionnaire.

Data Analysis

Data elimination

This study used three selective data elimination criteria to reduce possible confounding variables during the statistical analysis. First, students not enrolled in a participating technology-rich school or traditional school for the entire 1993-1994 school year were eliminated from the sample. This first criterion removed students from the sample who were not fully exposed to the treatment during the entire 1993-1994 school year (i.e., technology-rich environment) and were traditional-school students who during the 1993-1994 school year may have had experiences with technology environments not accounted for in this study. The criterion created a sample of 4th-grade, 6th-grade, and 11th-grade students who had attended their respective technology-rich schools or traditional schools for the entire 1993-1994 school year.

The second elimination criterion removed students whose student questionnaire information could not be matched with their ITBS, LPT, or TAP scores. This effort ensured that computer ownership and attitudinal data from the student questionnaire could be matched with students' academic achievement, ethnicity, and gender information from official school records. The second criterion created a sample of 4th-grade, 6th-grade, and 11th-grade students whose independent variables of type of school, gender, ownership, and ethnicity were matched with their respective dependent measures of academic achievement and attitude. Resulting sample sizes were 4th-grade Cooper Elementary School (n = 49) and Cary Elementary School (n = 44), 6th-grade Syms Middle School (n = 342) and Davis Middle School (n = 247), and 11th-grade Bethel High School (n = 255) and Kecoughtan High School (n = 178).

The final elimination criterion removed students whose ethnicity was reported as Asian, Native American, Hispanic, or undetermined. This was required due to the small numbers of selected categorical minority students at the respective schools. For example, Native Americans (n = 4) were reported at only one technology-rich school and none at the comparison traditional schools. This reduction criterion prevented the erroneous classification of under-representative ethnic groups into a single category. Additionally, the two largest ethnic groups (Caucasian and Black) in Hampton City Schools were identified for examination. Table 3.2 provides demographic data of participating schools. The resulting sample sizes were 4th-grade Cooper Elementary School (n = 47) and Cary Elementary School (n = 42), 6th-grade Syms Middle School (n = 337) and Davis Middle School (n = 244), and 11th-grade Bethel High School (n = 238) and Kecoughtan High School (n = 170).

Analysis Model

A general linear models analysis of variance (GLM) was conducted to analyze academic achievement and attitude data. The primary independent variable was the type of school with two levels (technology-rich and traditional school), with additional independent variables being gender, home computer ownership, and ethnicity. Table 3.5 presents the data analysis matrix for academic achievement and attitudes.

Table 3.5

Data Analysis - Academic Achievement and Attitudes by Grade Level

Source	Academic Achievement			Attitude		
	4th	6th	11th	4th	6th	11th
Main Effect						
Type of school (T)						
Two-way Interaction						
T x Gender (G)						
T x Ownership (O)						
T x Ethnicity (E)						
Three-way Interaction						
T x G x O						
T x G x E						
T x O x E						
Four-way Interaction						
T x G x O x E						

Note. The analysis of data is based on grade level and utilizes measures of academic achievement (ITBS, LPT, and TAP) and measures of attitude (student questionnaire).

The academic achievement dependent variables were composite scores of the ITBS (4th-grade), LPT (6th-grade), and TAP (11th-grade). The attitude dependent variables were one score for attitude towards school, one score for attitude toward technology, one score for attitude toward self, and one composite attitudinal score. The GLM was an appropriate statistical approach to analyze academic achievement data in that it could partition the variance into various sources, that is, main effect and levels of interaction (e.g., two-way, three-way, and four-way interactions). Additionally, the GLM was employed to analyze attitudinal data in that there were multiple independent variables and unequal cell sizes; therefore, the analysis revealed whether students were different on a specific aspect of attitude. The GLM examined data for interaction among the independent variables. The analysis required separate examination of the data from the three separate sets of matched schools (e.g., one set comprised of two high schools, one set comprised of two middle schools, and one set comprised of two elementary schools). The GLM significant findings (e.g., main effect and interactions) were examined using the Student-Newman-Keuls test with $p < 0.05$ established as the level of significance.

Chapter 4

Results

This research sought to determine if differences existed between technology-rich schools and traditional schools relative to student achievement and student attitude. The analysis employed a general linear model analysis of variance (GLM) to examine the study's general hypotheses and answer the four research questions. Of primary importance was the main effect of the independent variable, type of school (technology-rich and traditional). Also, statistically significant two-way, three-way, and four-way interactions among type of school and ancillary variables (gender, ownership, and ethnicity) were considered important. For each significant result a Student-Newman-Keuls post hoc test was conducted to determine where differences existed. Tables and results are presented in two sections: 1) statistical data analysis (by grade level) for academic achievement and 2) statistical data analysis (by grade level) for attitude.

Student Academic Achievement

Academic Achievement -- 4th-grade

The analysis of 4th-grade academic achievement data determined no significant difference in the main effect of type of school. Significance was determined for the two-way interaction of type of school and computer ownership ($p = 0.0441$). Table 4.1 presents results of the GLM of ITBS composite scores of 4th-grade students.

A post hoc examination of the two-way interaction of type of school and computer ownership indicates that 4th-grade students attending a technology-rich school and not owning a computer have significantly higher academic achievement scores ($p < 0.05$) than 4th-grade students attending a traditional school and not owning a computer ($\bar{X}$ = 118.509 vs. $\bar{X}$ = 111.206). Also, 4th-grade students attending a traditional school and owning a computer have significantly higher academic achievement scores ($p < 0.05$) than 4th-grade students attending a traditional school and not owning a computer ($\bar{X}$ = 118.315 vs. $\bar{X}$ = 111.206). Additionally, based on an examination of the average of mean scores of students attending a technology-rich school ($\bar{X}$ = 117.280) as compared to the average of mean scores of traditional-school students ($\bar{X}$ = 114.761), it was concluded that technology-rich students have a higher mean academic achievement score. Table 4.2 presents post hoc of interaction of type of school and 4th-grade computer ownership.

Table 4.1

General Linear Model -- 4th-grade Academic Achievement

Source	df	SS	MS	F
Main Effect				
Type of school (T)	1	204.996	7204.996	1.69
Two-way Interaction				
T x O (Ownership)	1	507.536	507.536	4.19*
Error	73	8832.544	(120.993)	
Total	88	11623.179		

Note. Value enclosed in parentheses represent mean square errors. Nonsignificant two-way, three-way, and four-way interactions omitted.

*$p < 0.05$

Table 4.2

Post hoc of 4th-grade Academic Achievement: Two-way Interactions (Type of School and Ownership)

Source	n	Mean	SD	Comparison of Differences
T1 x O1	20	116.050	9.769	-
T1 x O2	27	118.509	13.234	A
T2 x O1	19	118.315	12.098	A
T2 x O2	23	111.206	9.096	B

Technology-rich (T1) Own computer (O1)

Traditional (T2) No computer (O2)

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance. Comparison of differences: An "A" indicates a significant difference from "B" ($p < 0.05$).

Academic Achievement -- 6th-grade

The analysis of 6th-grade academic achievement data determined significance for the main effect of type of school ($p = 0.0071$). There were no significant two-way, three-way, and four-way interactions with type of school. Table 4.3 presents results of the GLM of composite LPT scores of 6th-grade students.

A post hoc examination to determine the source of variability of type-of-school data indicated that 6th-grade students attending a technology-rich school scored higher on the LPT than 6th-grade students attending a traditional school ($p < 0.05$). Table 4.4 presents post hoc examination of the main effect of type of school.

Table 4.3

General Linear Model -- 6th-grade Academic Achievement

Source	df	SS	MS	F
Main Effect				
Type of school (T)	1	8537.726	8537.726	7.30**
Error	565	660625.478	(1169.248)	
Total	580	784450.650		

Note. Value enclosed in parentheses represent mean square errors. Nonsignificant two-way, three-way, and four-way interactions omitted.

** $p < 0.01$

Table 4.4

Post hoc of 6th-grade Academic Achievement

Source	Mean	n
Type of School (T)		
Technology-rich	803.214	337
Traditional	795.447	244

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance

Academic Achievement -- 11th-grade

The analysis of 11th-grade academic achievement data determined no significant difference in the main effect of type of school. Significance was determined for the three-way interaction of type of school, gender, and computer ownership ($p = 0.0009$). Table 4.5 presents results of the GLM of TAP composite scores of 11th-grade students.

Table 4.5

General Linear Model -- 11th-grade Academic Achievement

Source	df	SS	MS	F
Main Effect				
Type of school (T)	1	2.731	2.731	.01
Three-way Interaction				
T x G x O	1	5518.256	5518.256	11.24***
Error	392	192499.912	(491.071)	
Total	407	222008.396		

Note. Gender (G); Ownership (O). Value enclosed in parentheses represent mean square errors. Nonsignificant two-way, three-way, and four-way interactions omitted.

***$p < 0.001$

A post hoc examination of the three-way interaction of type of school, gender, and computer ownership indicated that 11th-grade female students attending a traditional school and owning computers had significantly higher scores than 11th-grade female students attending a traditional school and do not own computers ($p < 0.05$). Additionally, the difference between traditional-school females who owned computers ($\overline{X}$ = 204.340) and those who did not own computers ($\overline{X}$ = 182.968) was 21.372 points in favor of computer owners. Conversely, the disparity between the academic achievement scores of females, owning ($\overline{X}$ = 194.707) or not owning ($\overline{X}$ = 192.977) computers, but attending a technology-rich school was 1.730 points in favor of computer owners. There was less disparity in academic achievement scores of technology-rich female students based on ownership than traditional-school female students based on ownership

(1.730 vs. 21.372). Table 4.6 presents post hoc of the three-way interaction of type of school, gender, and computer ownership.

Table 4.6

Post hoc of 11th-grade Academic Achievement: Three-way Interaction (Type of School, Gender, and Ownership)

Source	n	Mean	SD	Comparison of Differences
T1 x G1 x O1	64	196.453	23.725	-
T1 x G1 x O2	37	183.581	22.010	-
T1 x G2 x O1	70	194.707	22.997	-
T1 x G2 x O2	67	192.977	21.090	-
T2 x G1 x O1	47	193.031	28.364	-
T2 x G1 x O2	32	191.000	26.328	-
T2 x G2 x O1	44	204.340	17.448	A
T2 x G2 x O2	47	182.968	19.169	B

Technology-rich (T1) Male (G1) Own computer (O1)
Traditional (T2) Female (G2) No computer (O2)

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance. An "A" indicates a significant difference from "B" ($p < 0.05$).

Student Attitude

Attitude Toward School -- 6th-grade

The analysis of 6th-grade attitude-toward-school data determined significance at the $p < 0.0001$ level for the main effect of type of school ($p = 0.0001$). The analysis was also significant at the $p < 0.05$ level for the three-way interaction of type of school, gender and computer ownership (p = 0.0121). Table 4.7 presents results of the GLM of attitude-toward-school scores of 6th-grade students.

Table 4.7

General Linear Model -- 6th-grade Attitude Toward School

Source	df	SS	MS	F
Main Effect				
Type of school (T)	1	16.360	16.360	16.13****
Three-way Interaction				
T x G x O	1	6.429	6.429	6.34*
Error	565	573.057	(1.014)	
Total	580	607.769		

Note. Type of School (T); Gender (G); Ownership (O). Value enclosed in parentheses represent mean square errors. Nonsignificant two-way, three-way, and four-way interactions omitted. *$p < 0.05$ ****$p < 0.0001$

The post hoc examination of type of school indicated that 6th-grade students attending a technology-rich school scored higher on the attitude-toward-school measure than 6th-grade students attending a traditional school. Table 4.8 presents the post hoc of the main effect of type of school for 6th-grade attitude toward school.

Table 4.8

Post hoc of 6th-grade Attitude Toward School

Source	Mean	n
Type of School (T)		
Technology-rich	2.204	337
Traditional	1.864	244

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance.

A post hoc examination of the significant three-way interaction ($p = 0.0001$) of type of school, gender, and computer ownership indicated two interaction effects. Analysis indicated that 6th-grade technology-rich male students who owned computers had higher attitude-toward-school scores than 6th-grade traditional-school male students who owned computers and traditional-school female students regardless of ownership ($p < 0.05$). Also that 6th-grade technology-rich female students who did not owned computers had higher attitude-toward-school scores than 6th-grade traditional-school male students who owned computers and traditional-school female students who did and did not own computers ($p < 0.05$). Table 4.9 presents the post hoc of the three-way interaction of type of school, gender, and computer ownership for 6th-grade students.

Table 4.9

Post hoc of 6th-grade Attitude Toward School: Three-way Interaction (Type of School, Gender, and Ownership)

Source	n	Mean	SD	Comparison of Differences	
T1 x G1 x O1	86	2.395	1.171	A	A
T1 x G1 x O2	89	2.089	1.164	B	-
T1 x G2 x O1	78	2.000	0.789	B	-
T1 x G2 x O2	84	2.321	1.077	A	A
T2 x G1 x O1	53	1.811	0.941	-	B
T2 x G1 x O2	54	2.111	0.984	-	-
T2 x G2 x O1	60	1.750	0.894	-	B
T2 x G2 x O2	77	1.818	0.838	-	B
Technology-rich (T1)		Male (G1)		Own computer (O1)	
Traditional (T2)		Female (G2)		No computer (O2)	

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance. An "A" in a column indicates a significant difference from "B" in the same column ($p < 0.05$).

Attitude Toward Technology -- 6th-grade

The analysis of 6th-grade attitude-toward-technology data determined no significant difference in the main effect of type of school. The examination was significant at the $p < 0.05$ level for the three-way interaction of type of school, gender and computer ownership ($p = 0.0176$). Table 4.10 presents results of the GLM of attitude-toward-technology scores of 6th-grade students.

Table 4.10

General Linear Model -- 6th-grade Attitude Toward Technology

Source	df	SS	MS	F
Main Effect				
Type of school (T)	1	2.091	2.091	1.58
Three-way Interaction				
T x G x O	1	7.510	7.510	5.66*
Error	565	749.099	(1.325)	
Total	580	776.058		

Note. Type of School (T); Gender (G); Ownership (O). Value enclosed in parentheses represent mean square errors. Nonsignificant two-way, three-way, and four-way interactions omitted.

*$p < 0.05$

The post hoc examination of the three-way interaction of type of school, gender, and computer ownership indicated that 6th-grade technology-rich male students who own computers had a higher attitude-toward-technology score than traditional school 6th-grade males who owned computers and traditional school females who did not own computers

($p < 0.05$). Table 4.11 presents the post hoc of the three-way interaction of type of school, gender, and computer ownership.

Table 4.11

Post hoc of 6th-grade Attitude Toward Technology: Three-way Interaction (Type of School, Gender, and Ownership)

Source	n	Mean	SD	Comparison of Differences	
T1 x G1 x O1	86	2.069	1.299	-	A
T1 x G1 x O2	89	1.820	1.143	-	-
T1 x G2 x O1	78	1.948	1.194	-	-
T1 x G2 x O2	84	1.750	1.128	-	-
T2 x G1 x O1	53	1.584	1.008	B	B
T2 x G1 x O2	54	2.037	1.228	A	-
T2 x G2 x O1	60	1.983	1.049	-	-
T2 x G2 x O2	77	1.558	1.057	B	B

Technology-rich (T1) Male (G1) Own computer (O1)
Traditional (T2) Female (G2) No computer (O2)

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance. An "A" in a column indicates a significant difference from "B" in the same column ($p < 0.05$).

Composite Attitude (school, technology, and self) -- 6th-grade

The analysis of 6th-grade composite-attitude data determined significance at the $p < 0.01$ level for the main effect of type of school ($p = 0.0044$) and significance at the $p < 0.01$ level for the three-way interaction of type of school, gender and computer ownership ($p =$

0.0042). Table 4.12 presents results of the GLM of composite-attitude scores of 6th-grade students.

Table 4.12

General Linear Model -- 6th-grade Composite Attitude

Source	df	SS	MS	F
Main Effect				
Type of school (T)	1	36.653	36.653	8.18**
Three-way Interaction				
T x G x O	1	37.068	37.068	8.27**
Error	565	2531.496	(4.480)	
Total	580	2688.626		

Note. Type of School (T); Gender (G); Ownership (O). Value enclosed in parentheses represent mean square errors. Nonsignificant two-way, three-way, and four-way interactions omitted. $^{**}p < 0.01$

The post hoc examination of the main effect of type of school indicated that 6th-grade students attending a technology-rich school had higher composite-attitude scores than 6th-grade students attending a traditional school. Table 4.13 presents the post hoc of the main effects of type of school.

The post hoc examination of the three-way interaction of type of school, gender, and computer ownership indicated that technology-rich male students, regardless of computer ownership, had higher composite-attitude scores than 6th-grade traditional-school male students who own computers and traditional-school female students who did not own computers ($p < 0.05$). Table 4.14 presents the post hoc of the three-way interaction of type of school, gender, and computer ownership.

Table 4.13

Post hoc of 6th-grade Composite Attitude

Source	Mean	n
Type of School (T)		
Technology-rich	7.008	337
Traditional	6.500	244

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance.

Table 4.14

Post hoc of 6th-grade Composite Attitude: Three-way Interaction (Type of School, Gender, and Ownership)

Source	n	Mean	SD	Comparison of Differences	
T1 x G1 x O1	86	7.465	2.486	-	A
T1 x G1 x O2	89	6.966	2.357	-	A
T1 x G2 x O1	78	6.782	1.777	-	-
T1 x G2 x O2	84	6.797	2.215	-	-
T2 x G1 x O1	53	6.150	1.691	B	B
T2 x G1 x O2	54	7.240	2.362	A	-
T2 x G2 x O1	60	6.600	1.941	-	-
T2 x G2 x O2	77	6.142	1.804	B	B

Technology-rich (T1)	Male (G1)	Own computer (O1)
Traditional (T2)	Female (G2)	No computer (O2)

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance. An "A" in a column indicates a significant difference from "B" in the same column ($p < 0.05$).

Attitude Toward School -- 11th-grade

The analysis of 11th-grade attitude-toward-school data determined significance at the $p < 0.05$ level for the main effect of type of school ($p = 0.0116$). The analysis was also significant at the $p < 0.05$ level for the two-way interaction of type of school and gender ($p = 0.0334$). Table 4.15 presents results of the GLM of attitude-toward-school scores of 11th-grade students.

Table 4.15

General Linear Model -- 11th-grade Attitude Toward School

Source	df	SS	MS	F
Main Effect				
Type of school (T)	1	10.272	10.272	6.43*
Two-way Interaction				
T x G (Gender)	1	7.728	7.278	4.56*
Error	392	626.644	(1.597)	
Total	407	665.644		

Note. Value enclosed in parentheses represent mean square errors. Nonsignificant two-way, three-way, and four-way interactions omitted.
*$p < 0.05$

The post hoc examination of main effect type of school indicated that 11th-grade students attending a technology-rich school had higher attitude-toward-school scores than 11th-grade students attending a traditional school. Table 4.16 presents the post hoc of the main effect of type of school and ethnicity. The post hoc examination of the two-way interaction of type of school and gender indicated that 11th-grade male students attending a technology-rich school scored significantly higher on attitude-toward-school than male 11th-grade students attending a traditional school ($p < 0.05$). Table 4.17 presents post hoc of interaction of type of school and gender.

Table 4.16

Post hoc of 11th-grade Attitude Toward School

Source	Mean	n
Type of School (T)		
Technology-rich	2.710	238
Traditional	2.388	170

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance.

Table 4.17

Post hoc of 11th-grade Attitude Toward School: Two-way Interaction (Type of School and Gender)

Source	n	Mean	SD	Comparison of Differences
T1 x G1	101	2.742	1.375	A
T1 x G2	137	2.686	1.258	-
T2 x G1	79	2.126	1.125	B
T2 x G2	91	2.615	1.254	-
Technology-rich (T1)		Male (G1)		
Traditional (T2)		Female (G2)		

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance. An "A" in a column indicates a significant difference from "B" in the same column ($p < 0.05$).

Attitude Toward Technology -- 11th-grade

The analysis of 11th-grade attitude-toward-technology data determined significance at the $p < 0.01$ level for the main effect of type of school ($p = 0.0095$). Table 4.18 presents results of the GLM of attitude-toward-technology scores of 11th-grade students.

Table 4.18

General Linear Model -- 11th-grade Attitude Toward Technology

Source	df	SS	MS	F
Main Effect				
Type of school (T)	1	14.882	14.882	6.80**
Error	392	858.428	(2.189)	
Total	407	893.644		

Note. Value enclosed in parentheses represent mean square errors. Nonsignificant interactions omitted. $**p < 0.01$

The post hoc examination of type of school indicated that 11th-grade students attending a technology-rich school had higher attitude-toward-technology scores than 11th-grade students attending a traditional school. Table 4.19 presents the post hoc of the main effect of type of school.

Table 4.19

Post hoc of 11th-grade Attitude Toward Technology

Source	Mean	n
Type of School (T)		
Technology-rich	2.252	238
Traditional	1.864	170

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance.

Composite Attitude (school, technology, and self) -- 11th-grade

The analysis of 11th-grade composite-attitude data determined significance at the $p < 0.01$ level for the main effect of type of school ($p = 0.0047$). There were no significant interactions. Table 4.20 presents results of the GLM of composite-attitude scores of 11th-grade students.

Table 4.20

General Linear Model -- 11th-grade Composite Attitude

Source	df	SS	MS	F
Main Effect				
Type of school (T)	1	63.867	63.867	8.10**
Error	392	3091.066	(7.885)	
Total	407	3298.585		

Note. Value enclosed in parentheses represent mean square errors. Nonsignificant interactions omitted. **$p < 0.01$

The post hoc examination of type of school indicated that 11th-grade students attending a technology-rich school had higher composite-attitude scores than 11th-grade students attending a traditional school. Table 4.21 presents the post hoc of the main effect of type of school.

Table 4.21

Post hoc of 11th-grade Composite Attitude

Source	Mean	n
Type of School (T)		
Technology-rich	7.919	238
Traditional	7.147	170

Note. Student-Newman-Keuls test is a stepwise procedure for variability set at $p < 0.05$ for level of significance.

Summary

This chapter presented the analysis of data pertaining to academic achievement and attitude. The results indicated there were significant differences between the measures of academic achievement and attitude of students attending technology-rich schools and traditional schools. A discussion of results, specifics of determined differences, and the implications, conclusions, and recommendations are discussed in chapter five.

Chapter 5

Discussion of Results

The primary purpose of this research was to determine if differences existed between technology-rich-school students and traditional-school students in academic achievement scores and attitudes. The first portion of the presentation is a broad statement of research findings followed by a summary of grade-level findings. Within the grade-level section is found a detailed discussion and interpretation of results relative to academic achievement and attitude as related to each grade level. The second part, summarizes the research findings for both areas (achievement and attitude) across grade levels. After that summary, an analysis of the research in terms of general educational implications is presented. The final portion of the chapter provides recommendations for future studies and policy based on the study findings.

Results

In response to the four research questions, the general findings of this study indicate that students who attended technology-rich schools have higher academic achievement and attitudinal scores. For students attending traditional schools, significant within-group disparities were found in both academic achievement scores and in attitudinal scores based on the variables of gender and computer ownership. However, the effects of these two variables (gender and computer ownership) on students' achievement and attitude were reduced by attendance at a technology-rich school.

Findings academic achievement and attitude (4th-grade). The data analysis indicates that the attitude scores of 4th-grade students, regardless of type of school, did not differ significantly. However, there was a significant difference between the academic achievement scores of 4th-grade students attending a technology-rich school and those attending a traditional school based on the two-way interaction of school type and computer ownership ($p < 0.05$). Students who attended a technology-rich school and did not own computers scored higher on the Iowa Test of Basic Skills (ITBS) than students who attended a traditional school and did not own computers ($p < 0.05$).

Within groups, the difference between the academic achievement scores for 4th-grade students in the traditional school who owned computers and those who did not was conspicuously evident. Those who owned computers scored an average of 7.109 points higher ($\bar{X} = 118.315$ vs. $\bar{X} = 111.206$) on the ITBS than those students who did not own computers ($p < 0.05$). In contrast, mean academic achievement scores of the students within the technology-rich school differed by 1.459 points between the groups of students who owned computers and those who did not. Students' mean ITBS scores did not differ significantly within the technology-rich school between computer owners and non-owners. The disparity in the difference within each school--traditional schools (7.109 points) and technology-rich schools (1.459 points)--suggests that the technology-rich school moderates the effect of computer ownership on ITBS scores.

Technology usage example (4th-grade). Perhaps it is possible to gain some insights into the reasons for the significant cognitive impacts by examining a representative example of technology usage at the technology-rich school. A recent project allowed Cooper's student body to utilize technology to simulate the democratic process of voting which included casting votes, tallying votes, and presenting election results. The voting project was a partnership effort between high school students, who wrote the computer program which allowed the Cooper Elementary students to cast ballots in local elections, and elementary school students, who researched, wrote, and produced charts and graphics about the election results. The cognitive skills needed to establish and maintain the school's election process were utilized when students learned what steps were necessary to become an informed voter. The elementary school students researched the names and political positions of various candidates for local government offices. Media reports, campaign literature, and facts about candidates were scanned into computers and used as reference materials. After compiling the needed facts, the pupils created text via the computer, describing the candidates and their positions on the issues, thus exercising comprehension skills by translating, interpreting, and extrapolating information for other students to read.

Along with the comprehension skills, students used the communication skills of writing to convey information clearly and concisely to a particular audience--other students. Students made decisions about what information to include, how it should be organized and what would be the best format for the widest and easiest distribution to the student body. In effect, reading, researching, and writing were placed in a purposeful context. Academic skills, similar to those measured by the ITBS, such as grammar, mechanics, and spelling were used by students to complete the project. These skills were measured by the ITBS in the vocabulary, reading comprehension and language segments.

On election day, students throughout Cooper Elementary 'cast' their votes using the program written by the high-school pupils. The idea was that the elementary students would cast an informed vote for the candidate of their choice based on the information which had been gathered and provided to them by their peers. The opportunities for learning did not stop there. Votes were tallied, entered into a spreadsheet and then analyzed. Subsequently, graphs and charts were created by students and distributed to Cooper's students to inform them about the election outcomes, both student and actual city-wide outcomes. The student-created post-election graphs and charts were used later by teachers to instruct pupils about reading and interpreting visual representations of abstract concepts. Not only were reading and mathematics processes employed, but there was evidence that synthesis and evaluation skills were strengthened by the process of generating a spreadsheet and then converting the information to graphic form.

Projects such as the election project are possible in traditional schools. However, with limited time and material resources within traditional school environments, projects of this nature are difficult to do. The time and materials required to conduct the election project in a traditional school would strain, or possibly overwhelm, time and material limits. The initial gathering and dissemination of candidate information, gathering and tallying of votes, creation of charts and graphs, and the distribution of election results would consume a significant amount of instructional time and available materials. For example, in a traditional school, the creation of post-election graphs and charts would require students to acquire graph paper and other drawing materials. Students would need to determine, construct and layout appropriate graph scales, conduct manual calculations, draw, plot, and paste values on the charts and then reproduce the charts and graphs--a time consuming, tedious process.

In contrast to the traditional school process just described, the technology-rich school's students simply entered the raw data (election results) into a spreadsheet. The data entry process was followed by instructions to the computer to create various types of charts. Once the data was entered into the spreadsheet, more than twenty different types of charts and graphs were created in less than five minutes. In the example set forth, the technology-rich students, although having similar time constraints for educational activities, were able to accomplish projects much more quickly and easily through the use of the school's technology base.

Discussion of findings (4th-grade). The preceding example provides four possible reasons for the significant difference in academic achievement scores between the technology-rich students and the traditional-school students. One reason is that students in a technology-rich school have access to, and use of, the school's technology base for a variety of *expanded learning opportunities*, particularly if teachers are creative and motivated to experiment. The learning opportunities can range from knowledge acquisition to synthesis and evaluation in the context of a relevant, 'real-world' process--a process that involves dealing with work situations that might be encountered on the job or in a student's or adult's personal life. Perhaps, the use of the computer, either in the student's home or at school, provides a form of reinforcement of this 'real-world' process by helping students complete their own required work more quickly and efficiently. In the example of the post-election graphs and charts, technology-rich students focused more on the meaning and content of the charts and graphs than on their physical construction which is what is required when dealing with a job, a personal, or higher education situation. For example, once the raw data were entered into the software program, students could select one or more horizontal or vertical bar graphs, pictographs, comparison charts, pie charts, line graphs, or scatter graphs. Over twenty different software-driven graphs and charts could be created in less than five minutes. Students were able to quickly experiment with various forms of graphs and charts; therefore, the focus of student activity was on determining the most appropriate chart or graph to present the information. The basis for decision making was the meaning of the information, not the process of manual construction. The technology-rich students had learning opportunities, as in the case of creating and viewing multiple forms of graphs and charts, to synthesize and evaluate information.

Another possible reason for the significant difference in academic achievement scores between the students of the traditional school and the technology-rich school could be the capability of technology to provide *immediate rewards (positive feedback)* for the students' efforts. Both school and home computers would provide students with more opportunities for positive feedback in the form of quality output. In the example of the post-election charts and graphs, technology-rich students were able to direct the software to create quality products as contrasted to hand-drawn charts and graphs. Lines, points, and text that comprised the finished charts and graphs were aligned, readable, and clear. Students who had poor handwriting or limited drawing abilities were perhaps better able to take advantage of learning opportunities rather than being discouraged by frustration. In the technology-rich educational environment, students could have been more frequently exposed to positive feedback in the form of complete, eye-appealing, educational projects.

Additionally, the disparity of academic achievement scores between the technology-rich students and the traditional-school students could be associated with the *ease of project completion* experienced by the technology-rich students. As in the case of the post-election results, technology-rich students were able to quickly generate graphs and charts. Once the voting information was entered into the software, charts and graphs were produced within moments. There was little delay or hardship in the creation of the visual information, that is, the drudgery of manually creating graphs and charts was eliminated. Accordingly, teachers and students could expend more time on interpretation of the information, thus expanding student critical thinking opportunities. The ease with which projects were completed could have encouraged and fostered students' willingness to focus on expanded learning activities.

Because computers help students complete projects faster and more easily, these benefits might have led to increased computer usage, both at school and at home. In turn, increased usage might have provided the critical mass of usage for exercising such school skills as logical thinking, vocabulary knowledge, reading, writing, and computation. The heightened focus on thinking and the repeated use of school skills might have produced cognitive gains. Possibly, the focus and the practice made a positive impact on academic achievement as measured by ITBS scores.

A final reason for the difference in students' academic achievement scores could be that the technology-rich environment was more direct in providing *learning opportunities measured by the ITBS*. Using a computer might have reinforced those skills measured by the ITBS. It is likely that the exposure to a variety of educational activities which focused on information and 'thinking about thinking' in a systematic manner better prepared students for the successful accomplishment of ITBS test tasks.

Academic achievement and attitude (6th-grade). *Academic achievement*, *attitude-toward-school*, *attitude-toward-technology*, and *composite-attitude* scores were significantly different between technology-rich and traditional schools. One main effect statistic for *academic achievement* and two main effect statistics for *attitude* were significant. Sixth-grade students attending a technology-rich school achieved higher mean composite LPT scores than 6th-grade students attending a traditional school ($p < 0.01$), and 6th-grade students attending a technology-rich school attained higher composite-attitude scores ($p < 0.0001$) and attitude-toward-school scores ($p < 0.01$) than

6th-grade students attending a traditional school. Higher scores on the attitude instrument denoted more positive attitudes.

Three significant interactions were observed in the data analysis of attitude-toward-school, attitude-toward-technology, and composite-attitude scores. The interaction of school type, gender, and computer ownership produced higher *attitude-toward-school* scores ($p < 0.05$). 1) Females who attended the technology-rich school, regardless of computer ownership, obtained significantly higher mean attitude-toward-school scores than females at the traditional school ($p < 0.01$). 2) Additionally, 6th-grade males who attended the technology-rich school, regardless of computer ownership, obtained significantly higher mean attitude-toward-school scores than males who attended a traditional school and owned computers ($p < 0.01$). The analysis of *attitude-toward-technology* data shows a significant interaction effect between school type, gender, and computer ownership ($p = 0.05$). 3) Male students who attended a technology-rich school and owned computers had higher attitude-toward-technology scores than all other groups. These scores were significantly higher than the scores obtained by male traditional-school students (computer owners) and female traditional-school students (non-computer owners) ($p < 0.05$).

The interaction of school type, gender, and computer ownership also produced higher *composite-attitude* scores ($p < 0.01$). Male students who attended a technology-rich school and owned computers had higher composite-attitude scores than all other groups. These same male students scored significantly higher than male traditional-school students (computer owners) and female traditional-school students (non-computer owners) ($p < 0.01$).

Technology usage example (6th-grade). Insights to the findings of significant differences are examined in light of a representative example of technology usage at the technology-rich school. In this manner, the possible reasons for the significant impacts noted above can be more carefully investigated. The following example is provided for analysis.

Students at the technology-rich middle school were assigned a project to create 'flash cards' about major inventors. The project required students to select a specific inventor and then to research the inventor and invention. The ultimate aim was to produce inventor flash cards. The research was conducted electronically using CD-ROMs about inventors and inventions and on-line encyclopedias. Information concerning the selected inventors was downloaded from the electronic encyclopedias and consolidated into a single document. Graphics, notably photographs of inventors, were incorporated into the document and students subsequently added their own text. Students, working individually and in groups, evaluated the body of acquired research material to determine the most suitable items for the completed flash cards. The school's technology-base was used to print the completed inventor flash cards. Subsequently, students employed a computer-based graphics presentation program to create an electronic presentation for fellow students. The presentation process involved the production of computer-generated graphics, the incorporation of text, and the creation of note cards. The inventor-flash-card project allowed students at the technology-rich school to learn about history. Furthermore, it provided them opportunities to incorporate other subjects into the project (e.g., English and science). Cognitive skills, such as comprehension, formulation of ideas into text, vocabulary enlargement, and expansion of background knowledge were developed, refined, and practiced by students during the project.

Projects similar to the inventor-flash-card project could be accomplished by traditional-school students. Resources such as library texts, art materials, and additional working space would have to be dedicated to the project. In the traditional school, students would either have to gather information on their own, or class time would have to be diverted to research activities. Some students would not have the home resources (books in which to locate information or people who would be willing to take them to the library) to do the research. In any case, it would be difficult to acquire the same volume of information in the same amount of time in the traditional school that would be obtainable in a technology-rich environment. For example, in the case of a popular CD-ROM reference product, it took a 6th-grade student approximately ten minutes to acquire 78 articles and two pictures about Sir Isaac Newton, plus 27 articles on physics, 18 articles on science, and 11 articles on the laws of motion. In contrast, the non-technology method of data gathering concerning Newton took another 6th-grade student 25 minutes to find one article and to hand-write one paragraph. The technology-rich environment, as illustrated in the case of the inventor flash cards, supplied students with expanded learning opportunities provided by technology-based tools.

Discussion of findings (6th-grade). The preceding example provides three possible reasons for the significant differences found in *academic achievement*, *attitude-toward-school*, *attitude-toward-technology*, and *composite-attitude* scores between the technology-rich-school students and traditional-school students. First, technology-rich students may *perceive the benefits of technology*. Classwork and homework assignments change when children enter middle school, that is, the work becomes more complex, time consuming, and demanding than work at the elementary level. Possibly, middle-school students begin to perceive the benefits of technology (e.g., rapid access to data and neatly printed reports) in accomplishing classwork and homework. In the technology-rich school, students are able to use the school technology-base and teachers' expertise to accomplish complex academic tasks. Perhaps, technology-rich students rely increasingly on technology. The school's technology provides assistance in the creation of reports, charts, and graphics, in addition to preforming various tasks (e.g., calculating mathematical problems, sorting, and alphabetizing). Technology-rich students become more appreciative of the technology tools that assist in the completion of assigned tasks while providing learning opportunities. For example, electronic research requires students to incorporate decision making and categorization strategies. Students' knowledge and skills of technology are routinely applied to technology-based projects. These projects may be complex and diverse; however, technology, as a tool, assists students in completing assignments more promptly. Accordingly, the technology-rich students may perceive the benefits of technology, and that perception perhaps is reflected in academic achievement and attitude scores.

As in the example of the inventor flash cards, the school's technology-base permitted quicker and more efficient accomplishment of the complex inventor cards. Learning opportunities, such as information gathering, were conducted more rapidly and productively in the technology-based environment. Students were able to gather information (text and graphics) about inventors and inventions without spending a great deal of time finding printed material. The students' use of the school's technology facilitated the completion of the inventor flash cards, resulting in a more positive attitude toward school and technology. Traditional-school students may not have been afforded the benefits of technology (the quick and easy completion of such assignments); therefore, their attitudes towards school were less positive. Due to students' hands-on experience, the technology-rich students may have perceived the advantages of technology usage. In turn, the perception produced a more positive attitude towards school and technology.

Another possible reason for the differences in scores could be that the technology-rich environment promotes the *sharing of information* among and between students. The shared information incorporates both technology-based skills (e.g., key boarding, data retrieval, and software usage) and subject matter (e.g., geography and history). The technology-rich middle school encourages students to gather, share, and develop materials to complete intricate academic projects. The cooperative learning environment allows students to become peer tutors. In the process of peer teaching, students are exposed to expanded learning opportunities in a broad range of subject areas. Additionally, while expanded learning opportunities are made possible, students' attitudes can be affected in a positive manner. The technology-rich students are exposed not only to the information individually gathered but also to the information provided through peer teaching. The increased exposure to information and the cooperative environment may affect the students' academic achievement and attitude scores.

As in the example of the inventor flash cards, students worked among themselves to learn the required skills to create presentations. Although initially they were teacher directed, students became more self directed as the project progressed. Uploading and downloading data, searching electronic data, and manipulating data were required to create both the inventor flash cards and the class presentations. Students worked individually on the cards and worked in groups to create the electronic presentations. In essence, the students assisted and taught fellow students data gathering and information skills, while the teacher became a facilitator and resource person. More chances for learning were possible through the use of the school's technology. Students promoted learning to other students. Students were required to gather large quantities of information, synthesize the information, evaluate the relative importance of the information, and present a finished project. The collective work group environment, which in this case focused on the creation of the inventor flash cards, affected students' scores in attitudes toward school and technology as well as in academic achievement.

A third reason for the differences in achievement and attitude scores may be associated with the sense of *empowerment* gained during computer usage. Technology, hardware and software, is controlled by the user. Technology-rich students may feel a sense of control over the computer. This feeling of control over the computer may translate into a feeling of control over the general school environment. Normally, students in their middle-school years feel that everybody--teachers, parents and adults in general--is telling them what to do. Technology is not directive in nature. Students are able to experiment with technology without fear of criticism. In the technology-rich environment, students are able to work with other students, experiment with different software, and produce a variety of products (e.g., text, graphics, and charts) based on the students' inputs. Accordingly, students of the technology-rich educational environment may have a sense of empowerment which is reflected in their higher achievement and attitude scores.

Student empowerment was illustrated in the creation of a product through an educational activity--the inventor-flash-cards project. During that process, students directed the technology to conduct various operations. For example, students directed the hardware and software to change fonts, adjust screen pallets, and modify slide templates. As was expected, the technology conducted the adjustment operations as directed. Students felt a sense of empowerment in having effectively directed the hardware and software to accomplish the task which was indicated. These positive empowering experiences may be reflected in the attitude-toward-technology scores.

Academic achievement and attitude (11th-grade). Technology-rich school students scored differently on measures of *academic achievement*, *attitude-toward-school*, *attitude-toward-technology*, and *composite-attitude* than the traditional-school students. Three main effects, one two-way interaction, and one three-way interaction were found to be statistically meaningful. Attitude toward school, attitude toward technology, and composite attitude scores produced the three significant main effects. Attitude-toward-school data indicated a significant two-way interaction between the variables school type and gender. Academic achievement data generated a significant three-way interaction among the variables school type, gender, and computer ownership.

The analysis of *attitude-toward-school* data indicates that technology-rich-school students had higher attitude-toward-school scores than students attending the traditional school ($p < 0.05$). The data analysis also indicates a two-way interaction effect of school type and gender ($p < 0.05$) on attitude toward school. Between the types of schools, 11th-grade males who attended a technology-rich school had the highest attitude-toward-school scores of all groups. These males scored significantly higher than males who attended a traditional school ($p < 0.05$).

When analyzed, the *attitude-toward-technology* scores show that 11th-grade students who attended the technology-rich school had higher attitude-toward-technology scores than the 11th-grade students who attended the traditional school ($p < 0.01$). *Composite-attitude* data analysis shows that 11th-grade students who attended the technology-rich school had higher composite-attitude scores than 11th-grade students who attended the traditional school ($p < 0.01$).

The analysis of 11th-grade academic achievement data contained a significant three-way interaction among the variables of school type, gender, and computer ownership ($p < 0.001$). Eleventh-grade females who owned computers and attended the traditional school scored significantly higher than 11th-grade females who did not own computers and also attended the traditional school ($p < 0.05$). There was a difference of 21.372 TAP points in mean scores between these two groups. In contrast, 11th-grade females who owned computers and attended the technology-rich school did not score significantly higher on the TAP than 11th-grade females who did not own computers and also attended the technology-rich school. The mean score difference between these two groups of females at the technology-rich school was 1.730 TAP points which is not significant. What is shown with the above finding is that there is a wide mean-score gap between traditional-school females who own computers and those who don't. No such gap exists at the technology-rich school. When comparing the score gap for the traditional-school scores to the gap for the technology-rich-school scores, a difference of 19.642 TAP points exists between the two mean differences (21.372 - 1.730). The point disparity (19.642 TAP points) indicates that attendance at a technology-rich school minimized the impact of computer ownership on 11th-grade females.

Technology usage example (11th-grade). By examining a representative example of technology usage at the technology-rich high school, it is possible to gain insight into the viable reasons for the significant impacts cited above. The Tele-Olympics is a technology-based project conducted by an interdisciplinary team of teachers and students in physical education, English, math, and social studies activities at Bethel High School. Eleventh-grade students who entered and participated in the international Tele-Olympics were engage in Olympic-style track and field events during physical education activities. After completing the events, students' names, ages, events, and times were entered into a spreadsheet. Students electronically transmitted Bethel's data to participating schools world wide, and in turn, Bethel students received and downloaded data provided by other schools. The database which was created from the downloaded information provided aggregate, descriptive statistics about students from other schools. That data was consolidated with Bethel's own statistics. After consolidation, the Bethel students created reports and spreadsheets which identified the winner of each event. During the process just described, students were required to analyze the acquired data and create reports using the school's technology base. Subsequent to the analysis, students produced a class presentation. In English class students researched and created reports about human physiology and created individual and group class presentation. At the conclusion of the Tele-Olympics project, winners received international and local acknowledgments and awards.

The traditional school would find it extremely difficult, if not impossible, to conduct a project similar to the Tele-Olympics. By its very nature, the Tele-Olympics project necessitated the capability to record, receive, and transmit information electronically. A traditional school could conduct a similar event using the postal service as a mode of communication; however, class time, school and student resources, and postal costs would restrict participation. Additionally, for traditional-school students some learning opportunities would simply not be present for the development of specialized thinking skills. For example, traditional-school students would not have had the opportunity to develop the skills of downloading, analyzing computer spreadsheet, or manipulating electronic graphs and charts. The Tele-Olympics was an interdisciplinary project which incorporated reading, math, writing, research, data analysis and evaluation, and information synthesis to provide additional learning opportunities normally not associated with traditional physical education classes.

Discussion of findings (11th-grade). The findings will be discussed using the Tele-Olympics project as the example. Discussion will focus on the three main effect findings in *attitude-toward-school*, *attitude-toward-technology*, and *composite-attitude* scores. Additionally, the interactions brought to light relative to *attitude-toward-technology* scores and *academic achievement* scores will be addressed.

At a technology-rich school, *technology is routinely used* and incorporated into classwork by teachers and employed by students to complete classwork and homework. This frequent use of technology promotes familiarity with the capabilities of technology and reduces fear of technology. Due to daily exposure to technology, technology-rich-school students associate personal benefit with technology usage. On the other hand, traditional-school students do not have routine access to technology at school and may not associate personal benefit with technology. The routine access to, and use of, technology results in comparably more positive attitudes toward school and technology for technology-rich students. Practical application of technology in classwork and for homework completion, perhaps provides expanded learning opportunities which are reflected in the academic achievement scores of technology-rich students. Thus, it is possible that frequent and routine use of technology impacts attitude and academic achievement scores in a positive manner.

In the example of the Tele-Olympics, the teachers and students incorporated technology into the framework of physical education activities. After completing various track and field events (e.g., 200 and 400 meter runs), students recorded completion times for each event. The names of the students, along with age, date, event, time data were entered into a spreadsheet. Physical education classes do not normally lend themselves to the use of technology. Neither would the opportunity to gather data from other parts of the world in a timely fashion be a normal educational practice. However, in the technology-rich school, students uploaded the spreadsheet data to the school's file server and transmitted their information electronically. Additionally, the technology-rich school received information electronically from participating off-site schools. Students downloaded that information electronically into a spreadsheet. After reviewing the information, students imported the information to create phased reports and a final report. Not only were technology skills being practiced and developed during the Tele-Olympics project, but cognitive skills were being exercised. Students were required to analyze elements of age, type of event, event completion times, and relationships of student's physical performance. All the compiled information had to be translated into charts and graphs. Synthesizing the many pieces of information required considerable amounts of decision making and evaluative skills. The TAP language segments, in particular, test these evaluative skills.

Another possible reason for the difference in scores is that technology use in the technology-rich school provided students with opportunities to use, develop, and practice *real-world technology skills*. Information age jobs, in service industries and in high-technology industries, require knowledge of computers, information retrieval, and data analysis. Higher paying jobs in these work endeavors require high levels of technological skills. Students at the 11th-grade level were made aware of these requirements through guidance counselors, career planning information, college recruitment programs, and everyday observation of the jobs which people perform. The technology-rich school promoted the application of technology to 'real-world,' school-based problems and projects. Accordingly, students were able to develop, practice, and refine technology skills that are required for future jobs. The knowledge, the internalization of the need, and the connection seen between what students are doing in school and what is required in the world of work could account for the higher attitude scores obtained by the technology-school students.

In the case of the Tele-Olympics, students were able to practice skills required in the job market of today and tomorrow. Common tasks such as converting data to the appropriate format, uploading data, and transmitting data were developed and practiced. These are technology tasks which are used routinely in the information industries of today's job market. The technology-rich students participating in the school's physical education program not only practiced physical skills, but also honed skills required for tomorrow's job market. The Tele-Olympics project permitted students to analyze data, synthesize information, and determine the appropriate technique to present the results. The educational project was a learning activity designed to use real-world technology skills in the incorporation of technology into a physical education class.

The third reason for the differences in academic achievement and attitude scores is that technology provides *rapid feedback* to students and teachers. In an age of instant everything, students are accustomed to very quick results. Students want to know immediately how they are doing. Waiting for results is not a favorite activity of today's student. They are accustomed to the on-the-spot, CNN type of information access. Technology can, and does, provide instant feedback. Hardware and software will effectively respond to students' inputs (e.g., key strokes) thereby providing instant feedback as to performance. Additionally, errors made by students result in either a non-response or a message response (e.g., "Drive A not available." or "Try again.") which is presented to the student in a non-public, non-critical manner. This knowledge is particularly important if students are not doing well. The non-critical feedback enables students to learn from their mistakes in a somewhat more emotionally safe environment. The immediacy and non-critical nature of technological feedback might influence the attitude, and thus the attitude scores, of students at the technology-rich school.

To illustrate, the Tele-Olympics provided special learning opportunities normally not associated with any of the four classes involved, had those classes worked individually. Not only did students compete with students in other parts of the world, but the results of students' efforts were recorded and advertised internationally. Additionally, by having to present the results, they were able to practice, develop, and refine cognitive skills associated with creating and producing electronic presentations to fellow students. The interdisciplinary approach provided the students a notion about the interconnectedness of various disciplines.

The Tele-Olympics project provided students with an opportunity to practice physical skills and an opportunity to develop cognitive skills. Errors made by students in transmitting or receiving event data were immediately corrected. Also, positive feedback was provided during the execution of procedures to upload, download, and manipulate data. The feedback component of technology provided students immediate insight into command and processing errors. In general, however, feedback was a learning tool, not a criticism of individual performance or worth. Students learned academic skills while still maintaining positive attitudes. Achievement and attitude scores on the tests analyzed might be reflective of the opportunity of students to learn in a nonjudgmental atmosphere with immediate feedback for quick error correction.

Summary of Results

Students in the 4th-grade, 6th-grade, and 11th-grade, who attended the technology-rich schools, attained higher measures of *academic achievement* when compared to students of the same grade levels who attended traditional schools. Additionally, based on gender, there was less disparity in academic achievement scores between students within a technology-rich school than between students within a traditional school. Not only was academic achievement positively affected by attending a technology-rich school, but the disparity of scores based on computer ownership was noticeably reduced. At the 4th-grade level, computer ownership was a significant factor for traditional-school students, and less of a factor for technology-rich students. At the 6th-grade level, the type of school (technology-rich) was a factor in increased academic achievement. At the 11th-grade level, gender was a factor, as was computer ownership. However, at both the 4th-grade and 11th-grade levels of the technology-rich schools, the disparity in achievement scores (due to computer ownership) was minimal compared to students attending traditional schools. The data analysis suggests that the technology-rich schools promoted higher academic achievement scores when compared to traditional schools.

Simultaneously, the technology-rich schools also promoted higher scores in *attitude* towards school, technology, and composite attitude when compared to students at traditional schools. As with academic achievement, student attitude scores (traditional school) were affected by factors of gender and computer ownership. The analyzed data implies that technology-rich schools reduced the disparity in attitude scores based on gender and ownership.

As cited, the differences in academic achievement and attitude scores were perhaps attributable to the equitable learning opportunities afforded by the use of technology, expanded learning opportunities, rapid feedback, and development of real-world technology skills. The technology-rich school, regardless of grade level, appeared to promote increased opportunities to enhance and expand cognitive skills of students through the use of technology. As explained in the previous examples (e.g., election voting, inventor flash cards, and Tele-Olympics), technology allows information and data to be rapidly available and usable by students, possibly resulting in less frustration, more satisfaction with the completed assignment, and less time spent on non-productive activities such as manual data searches and handwritten reports. Although, these factors may appear minor, the cumulative effect may be that students develop a positive perception of technology and are allowed more time and freedom for knowledge acquisition, application, and evaluation. These factors perhaps affect and promote positive attitudes toward school and technology. Additionally, cognitive skills (e.g., reading, writing, grammar, mathematics, and spelling) are developed, practiced, and refined through the use of technology. These skills are measured by the ITBS, LPT, and

TAP in the vocabulary, reading comprehension, language, science, and mathematics segments.

Summary of Study

As indicated in Chapter I, the major issues addressed in this study revolve around two basic points: 1) the difficulty of the American system of education to provide equity and excellence and 2) the inability of the education establishment to determine the nature of the preparation needed for future citizens. American society is calling for reforms which address both equity and excellence simultaneously. Furthermore, society wants citizens who are prepared to live productive lives and who have appropriate skills for future job markets in the global economy. American schools are an important force relative to these demands. Equity and excellence are known factors which have been measured and expounded upon repeatedly until the topic have been belabored. The second point, however, is more challenging.

The unknown is the exact amalgam of restructured schools, curriculum alignment, and/or educational ethos which is required to satisfy the needs of America's children for tomorrow's world in an equitable and excellent manner. Critics assume that traditional schools are limited in their abilities to prepare students for the Information Age. The limitations are due in part to constraints on funding, management, and personnel resources. However, more confounding is the rapidity of the technological advancements which are making adjustments in educational thinking and practices extremely difficult and complex. Accurate information about programs and processes which contribute to equity and excellence while addressing future needs is critically short. However, school administrators, the public at large, and business and industry are searching for answers.

The requirement for technology-rich educational environments is currently a topic of academic discussion. The idea is to install technology in traditional schools in hopes of rendering a transformation. The technology-rich issue addresses both issues of equity and excellence. Furthermore, the application of technology to the traditional school requires and incorporates curricular criteria for school restructuring. The promise of the technology-rich educational environment is that it will positively affect students' attitudes and achievement while acclimating students to the milieu of a future society.

In light of these intentions, the research provided in this study contributes much needed empirical evidence about a technology-rich environment. The basic question which has guided this research is whether a technology-rich environment can significantly affect students' academic achievement and attitude. Unequivocally, the evidence presented supports the premise that the technology-rich environment does significantly and positively affect the academic achievement and attitude of students. More specifically, this study contributes evidence in support of the use of technology-rich environments to enhance learning and attitudes of students, particularly at the 4th-grade, 6th-grade, and 11th-grade levels. Currently, questions about the impact of the technology-rich environment on workplace productivity and future societal relevance cannot be answered. Only time and longitudinal research will tell.

Recommendations: Future Research and Policy

The complexity of the issues involved in restructuring curriculum to meet future educational needs necessitates careful attention. Recommendations for future investigation of concerns which have been identified as a result of this study and policy recommendations for educational organizations are presented:

• A study similar to this one should be conducted to an expanded population of Hampton schools. Notably, all grade levels at all technology-rich schools should be compared to the population of students attending traditional schools. This approach may more accurately define the benefits of Hampton's technology-rich concept and provide greater focus for schools and students requiring immediate application of technology.

- A longitudinal study (thirteen years) should be conducted, following students through elementary, middle, and high school. The focus should be to define, in quantitative and qualitative terms, the impact and effect of technology on academic achievement and attitude. An additional benefit of a longitudinal study would be the determination of specific grade levels which are significantly impacted by technology with regard to greatest academic and attitudinal gains.
- Continued expansion of the technology base at technology-rich schools within Hampton City Schools is recommended. This expansion should be examined as to impact on academic achievement and attitude of students. The dedication of increased resources may result in marginal gains over those already being experienced; however, the converse may also be the case.
- The use of technology in schools should continue into the future. Careful record keeping and accountability of activities needs to be created. Specifically, those educational activities which have provided the greatest benefits to students need to be recorded and shared with other schools within the system. Research should be conducted to document the specific educational activities and benefits to students from the perspective of parents, students, teachers, and administrators.

Central to urban studies are issues of policy and procedure. Research, unto itself, does not result in change. Only the modification of organizational policy, procedure, and process causes change. Therefore, it is deemed appropriate to proffer the following policy and procedure recommendations. These recommendations concern the operational implementation of technology capabilities within schools with a technology base, and those creating a technology base.

• A mainframe or central school system-wide file server with a variety of business and educational software products should be established and be electronically accessible to all schools. The cost of purchasing and maintaining (e.g., maintenance and personnel) individual mainframes or file servers at each technology-rich school will continue to increase. A more cost effective solution is to establish a central, system-wide file server or mainframe with required software products. This central, system-wide approach would expand accessibility, reduce operational costs, increase the useful life of hardware, increase usage accountability, enhance standardization, and further the compatibility of hardware and software.

• Teacher and administrator training in the use of technology should be an organizational requirement. A schedule of training needs to be firmly established, and most of all, firmly maintained for teachers and administrators. The training should be provided in a 'hands-on' mode and during normal work hours or in a compensatory manner (e.g., time or money given to staff). The focus of the training should be directed at classroom or laboratory use of hardware and software in student-oriented projects and activities.

• A specific network of teachers (e.g., math, science, reading, and special education) should be established and maintained by the school district and school principals. The purpose would be to reassign selected teachers to higher or lower level schools for short periods of time. The goal of the program would be to create an informal teacher-to-teacher communication network and to provide cross-fertilization of ideas and concepts for use in educational activities which incorporate technology. The reassignment program would promote technology-based educational projects between high school, middle school, and elementary school students and teachers and provide expanded educational opportunities for students.

• Schools which have a technology base, or are establishing a technology base, should expand or establish mandatory technology courses for students. Furthermore, courses with technology integrated into course work should be expanded. Exposure and use has been shown to significantly benefit students; therefore, increased usage and awareness will result in increased benefits. Additionally, newly created technology-rich schools should establish an enlarged menu of required courses which incorporate technology on a daily basis.

• A teacher-technologist or equivalent position should be created at each school with a technology base. The primary purpose of the position would be to provide on-site technology training to teachers, administrators, and students, expand capabilities for use of the technology base, and maintain the school's technology base. Accordingly, the position needs to filled by a "true" technologist. The minimum position criteria should included experience in network management (e.g., file server and mainframe), software and artificial intelligence programming, construction and use of robotics, and software and hardware development and management. Important to this recommendation is that the teacher-technologist position is not just an experienced software user, or someone interested in technology, or an additional duty for an existing teacher position.

Technology, in the future, will have a significant impact on the quality of life. Organizations and individuals will increasingly rely on the capabilities of technology to conduct all manner of activities. The task of preparing for a society based on technology requires that schools, local governments, businesses, and individuals work together to prepare today's students for tomorrow's world. Success will be measured in terms of future citizens who are productive in their personal and professional lives. The specifics of the task may be difficult to define, but technology will form the core and enveloping environment of tomorrow's world and culture--the Information Age.

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Appendix A

Iowa Tests of Basic Skills (ITBS)

and the

Tests of Achievement and Proficiency (TAP)

The following is an excerpt from the Manual for School Administrators, Levels 5-14, for the Iowa Tests of Basic Skills (ITBS) and the Tests of Achievement and Proficiency (TAP) by the Riverside Publishing Company.

Part 3 Norms Provided with the Tests

NATURE AND PURPOSES OF TEST NORMS

There are two approaches to the interpretation of results on an achievement test. In interpreting the total raw score on a test, i.e., the number of items answered correctly by a given pupil, a *norm-referenced* interpretation is employed. If attention is centered on performance on a single item or on a homogeneous group of items sampling a particular skill or trait, a *criterion-referenced* interpretation is often employed. Both types of interpretation are appropriate with the *Iowa Tests of Basic Skills,* and both types of interpretation involve a combination of normative information and subjective judgment.

The number of exercises a pupil answers correctly on a test, the raw *score,* means very little by itself. The magnitude of a raw score is almost wholly dependent upon many arbitrary characteristics of the test, such as the number of items on the test, the number of items attempted, and the difficulty of the exercises. To interpret a raw score productively, it is necessary to determine how it compares with a *distribution of* raw scores made by pupils in well defined and meaningful reference groups of similar characteristics.

There are essentially two ways in which we may employ reference groups to make a raw score meaningful. First, we may use a *single* reference group of pupils to determine where any given raw score stands in the distribution of scores for this group. Second, we may use a *series of* reference groups, obtain an average for each group, and determine how the raw score relates to this series of averages. All types of norms and derived scores employ a *single reference* group or a series of reference groups in one of these two ways.

TWO KINDS OF SCORES: FOR MEASURING DEVELOPMENT AND STATUS

In making norm-referenced interpretations, users need two kinds of scores.

The first, *status* scores, tell us how a pupil's test performance compares with that of others in a given *reference group* the class, the district, the state, the nation, etc. Status within a *single* reference group is usually expressed in terms of percentile ranks, stanines, or normal curve equivalents.

The second type of score is *a developmental* score. Developmental scores enable us to compare pupil performance with that of a *series* of reference groups that differ systematically and developmentally in average achievement, usually *either age groups or grade groups*.

In assessing growth or improvement, developmental scores are essential. Because most instructional groups are designated by grade rather than age, most developmental scores variously known as grade-equivalents, grade level indicators, growth scale values, or expanded standard scores are derived from *grade-referenced groups*. The psychometric properties of these developmental scales differ somewhat, but they are all derived *from* essentially *the* same data base.

TYPES OF NORMS PROVIDED WITH THE IOWA *TESTS OF BASIC SKILLS*

The types of norms to be preferred in the interpretation of measures of school achievement are a matter of some debate. Each type yields somewhat different information, and hence each augments and supplements the others. At the same time, each type of norm suffers specific weaknesses and is subject to different misuses and misinterpretations. Test users must judiciously decide which of the different types of norms available will promote the most effective and valid use of tests and test results in their schools to serve the specific *purposes of* the local program.

A brief description of the two basic reporting systems employed with the *Iowa Tests of Basic Skills was* presented in Part 1. These systems employ (1) gradeequivalent scores (GE) or (2) developmental standard scores (DSS) as the basic units of measurement. Each is supplemented by percentile norms and stanines for appropriate reference groups.

Separate norms are provided for *pupil scores, school averages,* and *item performance.* Table 3.1, on the next page [page omitted], lists the various types *of* norms available with the *Iowa Tests of Basic Skills* and may be used to locate the norms tables used in converting *ITBS* scores.

INTERPRETATION OF DIFFERENT TYPES OF SCORES AND NORMS

Grade-Equivalents (GE)

The grade equivalent score scale is a developmental scale. It is a *continuous* score scale that represents the entire range of skills development in the elementary school and is used to relate raw scores from the various levels to each other. *The range is from* PO (PreKindergarten) to 1-39. The unit of measurement is one-tenth of the difference between medians for successive grades.

The *grade-equivalent of a given raw score on a* test indicates the grade level at which the typical pupil makes the raw score. In scores between K2 and 88, the first digit represents the grade and the second digit the month within the grade in which the typical pupil makes the corresponding raw score. For example, if a pupil makes a grade-equivalent of 63, this means that the raw score on the test is the same as that made by the typical or median pupil in the sixth grade at the end of the third month in that grade. Similarly, if the pupil makes a grade-equivalent of 40, this means that the test performance equals that of a typical pupil just beginning the fourth grade.

Grade equivalents below K2 and above 88 may not be interpreted literally as indicating grade and month. They were derived statistically in such a manner as to extrapolate growth patterns established for different ability levels in the GE range between K2 and 88.

Grade-equivalent scores are useful for monitoring growth. They are simple, meaningful, and have direct *normative* meaning. In the Grades K-8 range, the average yearly growth is 1.0 points by definition. Just as talented pupils should be expected to gain more than 10 points in one year, it is unreasonable to expect pupils of below average ability to achieve a full years growth in that time. Average annual growth rates for pupils at various achievement levels are illustrated in Table 3.2 [omitted].

Grade-equivalent scores have been criticized, not so much because of their psychometric characteristics, but because they may be misinterpreted or misused. The grade equivalent should be regarded as an estimate of where the pupil *is* along a developmental continuum, not where he/she *should be* placed in the graded organization of the school. Suppose, for example, that on Test R (Reading), taken in the fall, a fifth grade pupil makes a grade-equivalent score of 72. This score ranks at the 90th percentile in the fall fifth grade norms, meaning that 90 percent of the pupils scored lower and 10 percent scored as well or better. This means that the pupil performed very well *in comparison to* *other pupils in the fifth grade.* A grade-equivalent of 72 does not indicate readiness for the seventh grade curriculum or that the pupil should skip the sixth grade.

A second possible misinterpretation stems from the fact that identical grade-equivalents earned on different tests do not necessarily represent equally good performance. For comparing a pupil's present *status* in a group from test to test, grade-equivalent scores may be misleading, particularly if they are well above or well below average. For this type of comparison, percentile ranks are more appropriate. Suppose, for example, that a third grade pupil has earned a grade-equivalent of 62 on Test R (Reading) and a grade-equivalent of 53 on Test M (Mathematics Total). From this evidence, one might conclude that this pupil's ability is better in reading than in mathematics. Actually, in comparison to *others in this grade,* it is not true; the pupil ranks at the 99th percentile on both tests. This fact is not apparent from the grade equivalents. The explanation is that the range of grade - equivalent scores in mathematics is narrower than that in reading, especially in the lower grades. This is true probably because of the manner in which mathematics skills are developed in the elementary school instructional program. Mathematics skills are somewhat more sequential in nature and tend to be more rigidly "graded" than reading skills.

These limitations apply to the interpretation of grade equivalent scores on any test. It does not follow, of course, that grade equivalents should not be used at all. They are convenient and useful for indicating developmental level and for determining pupil growth, but they should not be used to determine a pupil's standing in grade or relative performance on different tests. The percentile norms are provided for the latter purposes.

Developmental Standard Scores (DSS)

For most purposes, the use of grade equivalent scores is recommended for describing level of pupil development, for determining growth, and for computing group averages. The developmental standard score reporting system was designed primarily as an alternative reporting system for users who are concerned with possible misuses of grade-equivalents.

The developmental standard scores employed with the *Iowa Tests of Basic Skills* are often referred to as extended or expanded standard scores. They are used to relate performance longitudinally, both between grades on the Primary and Multilevel Batteries and between the *ITBS* and the *Tests of Achievement and Proficiency* in Grades 9-12.

The *ITBS* developmental standard scores have technical properties similar to grade-equivalents and, because of this, share most of the advantages and disadvantages attributed to grade-equivalents. Both types of scores are based on the same standardization data from *grade referenced* groups. Both reflect increasing variability in achievement as pupils progress through the grades. Both reflect essentially the same grade-to-grade overlap.

One of the primary differences between the two score scales is that developmental standard scores were derived using the assumption that performance within any grade level is normally distributed, whereas within-grade distributions of grade-equivalents tend to be platykurtic (i.e., "flatter" than normal) and somewhat asymetrical. As was pointed out in Part 1, another major difference is that grade equivalents reflect a relatively uniform rate of annual growth while developmental standard scores show a decreasing growth rate as pupils progress through the grades.

The developmental standard score scales were established with average scores of 100 in Grade 3 and 160 in Grade 8 on all tests for the fall 1984 national standardization of the *ITBS* Multilevel Battery. The average annual growth between Grades 3 and 8 is, thus, 12 points per year. The scales were then extended upward for *TAP* and downward for the *ITBS* Primary Battery through a series of standardization and equating studies. Average annual growth rates for pupils at various achievement levels are illustrated in Table 3.3 [omitted].

The major limitation of developmental standard scores is that they have no direct normative meaning. For example, a standard score of 133 on the Vocabulary test does not tell anything about a given pupil's developmental level until it is related to grade medians (e.g., 133 is between the Grade 5 fall median of 124 and the Grade 6 median of 136). In addition, because average annual growth differs from grade to grade and from test to test, the interpretation of developmental standard score gains from year to year is more difficult than for grade-equivalents. (See Part 1, p. 9, and Tables 3.2 and 3.3, for comparisons of average growth rates.)

Percentile Ranks (PR)

A percentile rank indicates the relative standing of a pupil in comparison to other pupils. The percentile rank tells the percent of pupils in a particular norm group who obtain lower scores. Thus, for example, if a pupil earns a percentile rank of 70 on a particular test, he/she scored better than 70 percent of the pupils in the norm group and 30 percent scored as well or better.

Of course, percentile ranks differ from group to group and from one time of year to another. A pupil is simultaneously a member of a large number of different groups: the pupils in the class, the building, the city system, the state, the region, the country; pupils of similar ability, socioeconomic status, etc. Percentile norms for a number of different reference groups are supplied with the *Iowa Tests of Basic Skills*. These are described briefly below. *In reporting results, it is important that teachers and parents know with which norms group the pupils are being compared:* national, state, large city, local, etc.

National Percentile Norms Within Grade for Grade Equivalents. The tables of national percentile norms for grade-equivalents are in Part 7 of the *Teachers Guide*. They are based on a large national sample, selected to be representative with respect to region, size of community, and socioeconomic status. They show the percentile ranks of scores for each grade for three times of the year: fall, midyear, and spring.

Median testing dates are shown below. Norms for fall and spring for Grades K-8 are empirical. Norms for midyear were determined by linear interpolation. Norms for Grade 9 were estimated from the results of a special study used to equate the scores from Level 14 of the *Iowa Tests of Basic Skills* to Level 1-5 of the *Tests of Achievement and Proficiency*.

	Fall	*Midyear*	*Spring*
ITBS Primary(Levels 5-8)	October 31	January 31	April 30
ITBS ML (Levels 9-14)	October 31	January 31	April 30

Norms for Large City Schools. Educational programs and populations in large cities have unique characteristics that affect test performance. Cooperation of large cities (250,000 and over) in providing representative samples of pupils for the national standardization made possible the preparation of special percentile norms for grade--equivalents that are believed to be highly representative. These norms are provided, both for pupils and schools, for Grades K-9, in the publication *Percentile Norms for Large Cities (9-50282)*.

Norms for Catholic Schools. Special percentile norms for grade-equivalents are also available for pupils attending Catholic schools and for Catholic school performance. A description of the selection of the Catholic sample and the procedures used in deriving the norms for Grades K-9 are described in the publication *Percentile Norms for Catholic Schools (9-50284)*.

Norms for High and Low Socioeconomic Schools. One of three primary variables used in stratifying the *ITBS* national standardization sample was the socioeconomic status (SES) of the community as determined from the 1980 census. The socioeconomic indices were (1) median years of education of the population 25 years old and over and (2) median family income in thousands of dollars. The socioeconomic index was an equally weighted composite of these two variables. This index was not only the basis for stratification of the national sample but was also used to identify the subsample of buildings used in deriving special pupil and building norms for high and low socioeconomic attendance centers. Norms are provided for fall, midyear, and spring for Grades K-9. They are published as two separate Booklets: *Percentile Norms for High Socioeconomic Schools* (9-50286) and *Percentile Norms for Low Socioeconomic Schools* (9-50288).

Local Norms. Many school systems or units can benefit from the development of local norms. Most school situations are unique in some respects; each school district presents special problems and puts a specific curricular emphasis upon, and devotes a different proportion of time to, the various basic skills areas. In many instances the unique elements may be of only minor importance. In others, however, they may render a situation quite atypical. Local norms permit an interpretation of individual achievement in terms of local conditions. Such interpretations may be as valuable as those based upon a more comprehensive reference group. Various local norms services, available through The Riverside Scoring Service, are illustrated in Part 4.

Stanines

Stanine scores are normalized standard scores with a range from 1 to 9, a mean of 5, and a standard deviation of 2. Like percentile ranks, they are status scores within a *particular* norm group. In fact, they may be regarded as a rather coarse grouping of percentile ranks; the relationship is as follows:

Percentile ranks	**Stanine**
96 and up	9
89-95	8
77-88	7
60-76	6
40-59	5
23-39	4
11-22	3
4-10	2
Below 4	1

Conversions from grade-equivalents to stanines are included as part of the tables for converting GE's to percentile ranks in Part 7 of the *Teachers Guide*. Advocates of stanine reporting cite the fact that the single digit scale is simple and convenient to use and that its use minimizes the apparent importance of small score differences.

On the other hand, the stanine scale may be regarded as unnecessarily coarse particularly for relatively reliable tests. For example, ali pupils scoring between the 40th and 60th percentiles are assigned a stanine of 5; however, a pupil scoring at the 59th percentile (stanine 5) is probably much more similar in achievement to a pupil scoring at the 61st percentile (stanine 6) than to one at the 41st (stanine 5). In some instances the width of the stanine band exceeds the standard error of measurement.

Another reservation about the use of stanines is that *by definition* they are equally variable from test to test and from grade to grade. There is evidence that skills development in the elementary schools is more variable in subjects such as reading, in which the pupils have many opportunities for advancing "on their own," than in subjects such as mathematics, in which pupil progress is more rigidly controlled through placement of concepts and processes in the curriculum. Also, it is to be expected that because some children progress at faster rate than others, they grow farther apart as they progress through the grades, particularly with respect to nonmastery objectives. This increased variability is reflected in grade equivalents and developmental standard scores but not in stanines.

Normal Curve Equivalents (NCE)

Normal Curve Equivalents are normalized standard scores with a mean of 50 and a standard deviation of 21.06. The range of NCE's is from a score of 1 (corresponding to a percentile rank of 1.0) to a score of 99 (corresponding to a percentile rank of 99.0). NCE's have little direct normative meaning to the typical user. To interpret NCE's, it is necessary to relate them to other status scores based on a single reference group, such as percentile ranks or stanines. For those who are accustomed to interpreting stanines, NCE's may be thought of as roughly equivalent to stanines to one decimal place. For example, an NCE of 73 may be interpreted as stanine of 7.3. The nature of the relationship between NCE's and percentile ranks and between NCE's and stanines is shown in the following table:

NCE-PR Relationships		*NCE-Stanine* Relationships	
NCE	PR	NCE	Stanine
99	99	86 up	9
90	97	76-85	8
80	92	66-75	7
70	83	56-65	6
60	68	45-55	5
50	50	35-44	4
40	32	23-34	3
30	17	15-24	2
20	8	1-14	1
10	3		
1	1		

The main advantage of NCE's is that they are derived through the use of comparable procedures by the publishers of the various tests used in Chapter 1 projects. NCE's used in Chapter 1 evaluation must be based on empirically established norms for a particular grade and time of the year. This leads to standardization and parability of reporting *procedures*. This does not me *results* from different test batteries are interchangeable, however. Tests differ in content, and norms are based on different samples tested at different points in time.

Area Totals and Composite Scores

For Levels 7 and 8 of the Primary Battery and for Levels 9-14 of the Multilevel Battery, total test area scores are provided. These are computed as the averages (means) of the tests. Total L (LT) is the average of the four Language tests: Spelling, Capitalization, Punctuation, Usage and Expression. Total W (WT) is the average of the Visual Materials and References tests. Total M (MT) is the average of the three Math tests: Concepts, Problems, Computation.

Two battery composites are provided, a Basic Composite (BC) and a Complete Composite (CC). These are averages (means) of the main test scores and the total test area scores. For Level 6, the Basic Composite does not include Test R, Reading. For Levels 7-14, the Basic and Complete composites are based on the tests in the Basic and Complete Battery test booklets. The composite scores are computed as follows:

Basic Composite

Level 5	(Li + WA + V + L + M) / 5
Level 6	(Li + WA + V + L + M) / 5
Levels 7-8	(WA + V + R + L-1 + MT) / 5
Levels 9-14	(V + R + L-1 + MT) / 4

Complete Composite

Level 5	------------------
Level 6	(Li + WA + V + R + L + M) / 6
Levels 7-8	(Li + WA + V + R + LT + WT + MT) / 7
Levels 9-14	(V + R + LT + WT + MT) / 5

The composite scores are computed only when *all of* the scores listed above are present. Social Studies and Science scores are *not* included in either composite. The composites are computed for all types of scores except raw scores and percentile ranks: GE's, predicted GE's, DSS's, predicted DSS's, stanines, and NCE's.

Skill Norms and Item Norms

Two types of criterion-referenced reports are available with the *Iowa Tests of Basic Skills:* group reports and individual reports.

Group reports include Group Item Analysis, Building Criterion-Referenced Skills Analysis, the Class Diagnostic Report and the Class Item Response Record. These involve reporting in terms of percent correct for the test, or for each major *skill* in the test, or for each item that measures each skill. Group reports are useful in diagnosing specific strengths and weaknesses in skill or item performance at the class, building, or system level.

Individual reports are the Student Criterion-Referenced Skills Analysis, the Individual Performance Profile, and Individual Item Analysis. These reports may be used in diagnosing strengths and weaknesses in skill or item performance and in reporting results to pupils and parents. On both types of reports, national skill and item norms in terms of national percent correct are provided. The norms for fall and spring were obtained from results of the national standardization. The norms for midyear were established by interpolation. Skill and item norms are also provided in *Detailed Skills Objectives and Item Norms,* Form G (9-50278), and Form H (9-50281).

In each test, easy items are used to discriminate among the least able pupils, average items are used to discriminate among pupils at all levels of ability, and difficult items are used to discriminate among superior pupils or those advanced in development. The item norms show

how easy or difficult the items are in each test for each grade and each time of year. The "scale" below may be used as a guide in interpreting item or skill difficulty.

Above 90	Very Easy
80-90	Easy
70-79	Fairly Easy
50-69	Average Difficulty
30-49	Difficult
Below 30	Very Difficult

Even though most criterion-referenced interpretations involve the use of skill or item norms, subjective standards are also important. Differences in ability levels of groups of pupils call for different standards and expectations. Discrepancies between expected and actual performance should be evaluated and interpreted in light of local provisions for developing the particular skill.

It should also be noted that the difficulty of a given item Depends not only on the inherent difficulty of the skill vested but also on the level of mastery required by the item, he setting in which the item is placed, the attractiveness of the distracters, etc. For example, an item that 80 percent of the pupils in a given school answer correctly may represent a skill that is extremely important for all pupils and one that should require immediate attention. On the other hand, an item that 40 percent of the pupils answer correctly may represent a difficult concept, with an item norm of 30 percent or so, that only the most able and talented pupils should be expected to master.

Norms for School Averages

To determine the relative status of grade averages for a given school, norms for school averages are required. The norms for school averages were based on weighted frequency distributions of school averages obtained in the national standardization program. Each building (attendance center) was considered as a separate unit. The Participating schools are listed in Part 5.

Tables of national percentile norms for grade equivalent school averages are in Part 7 of this Manual. School averages (means) were computed to one decimal place by adding the scores for all of the pupils who took each test and dividing by the number of pupils. To look up the percentile rank of an average, round the average to the nearest integer and read the percentile rank from the proper column in the table.

Norms are presented for three times of the year: fall, midyear, and spring. The fall and spring norms are based on empirical results of the national standardization; those or midyear were established through interpolation. The norms for Grade 9 were established in a special study linking the results of ITBS and *TAP* in Grades 8 and 9.

It might be expected that the medians of the distributions of averages would be the same as the medians of he distributions of pupil scores. However, the medians of the distributions of school averages differ considerably across tests, even within the same grade. For example, in the Grade 7 fall norms, in which the medians of *pupil scores* for all tests are 71 .8, the medians of *school averages* range from 71.2 for Test M-2 to 73.3 for Test R. There are an almost infinite number of score combinations which will produce a given average: scores symmetrically arranged about their means, a few very high scores balanced by a large number of moderately low scores, etc.

The characteristics of distributions of school averages vary considerably across tests and grades. For this reason, it is necessary to empirically derive norms for averages; i.e. to compute school averages, place them in distributions, and compute their percentile ranks as was done in the standardization program.

School Norms vs. Pupil Norms

The Norms for School Averages differ markedly from the norms for pupil scores that are supplied in the *Teachers Guides*. School averages are not nearly so variable as individual pupil scores. Obviously, the mean score in the best school will not be as high as the score made by the best pupil in that school, nor will the mean score in the lowest school be as low as the score of the lowest pupil in that school. Hence, the percentile ranks in the two tables often differ considerably, particularly at the extremes of the scale. On Test R, in the fall, for example, a fifth grade average GE of 70 exceeds the average score made in 99 percent of all buildings tested; but it exceeds the individual scores of only 88 percent of all pupils tested in the fifth grade.

The difference in the variability of pupil scores and school averages is illustrated in Figure 3.1 [omitted] for Test R: Reading in Grade 5. The distributions of pupil scores and school averages are plotted in terms of national grade equivalents. Below the national grade equivalent (NGE) scale, the national percentile ranks (NPR) are shown both for pupil norms and school norms.

This illustrates that the range in pupil scores is much greater than the range of school averages. The range in pupil scores from the 1st percentile (GE=20) to the 99th percentile (GE=90) is 70 GE units. The range in percentile ranks of school averages is from 35 to 70 = 35 GE units. On the Reports of School Averages, both types of percentile ranks are reported. The two percentile ranks serve two completely different purposes.

The national percentile rank in the pupil norms is to be interpreted as the percentile rank of the average *pupil* in the local grade group among the *pupils* in the nation. This rank may be used to indicate the general level of performance of the group (class, building, or system).

The national percentile rank in the school norms may be used to compare the local average with the averages of other schools in the nation. It indicates specifically where the *local average* ranks among the *school averages* that were obtained from the national standardization.

Strictly speaking, neither grade-equivalents nor developmental standard scores should be used in comparing performance across tests. Pupil or school percentile ranks are equally valid for this purpose. Differences in terms of *school* percentile ranks are very sensitive to relatively small differences from test to test. Small differences in performance may appear to be exaggerated. On the other hand, *pupil* percentile ranks are not so sensitive to minor differences. Substantial discrepancies in pupil percentile ranks constitute more dependable evidence of genuine strengths and weaknesses.

Some Additional Cautions and Suggestions

1. As was indicated in the previous section, school averages are relatively more homogeneous than pupil scores. The range from the lowest to the highest ranking school is not great, particularly in lower grades. As an example, the fall percentile norms for the Grade 3 Total Math averages are shown at the right [omitted]. The range from the 1st to the 99th percentiles (23 to 42) is only 1.9 grade equivalent units (1.9 "grades"). It should also be noted that a small increase in average GE makes a large difference in percentile rank, particularly in

the middle of the distribution. For example, an average GE of 32.0 ranks at the 46th percentile, and an average GE of 33.0 ranks at the 57th percentile. An increase of just one "month" makes a difference of 11 percentile ranks. For these reasons, little attention should be paid to minor differences in percentile rank.

2. In the norms tables in Part 7 only the percentile ranks of integer values of averages are shown. However, in the Reports of Averages, the average GE or DSS is reported to one decimal place, and the percentile rank reported has been computed by interpolation. For example, for a Grade 3 Total Math average of 30.4, the estimated PR would be .4 of the distance between 27 and 36 which is 31.

3. Strictly speaking, these norms for building averages should not be used in interpreting school *system* or district averages. For the latter purposes, norms for system averages are needed. However, in a national standardization program, it is impracticable to test more than a small fraction of pupils and buildings in most systems. It is thus impracticable to secure dependable norms for system averages. Such averages would, of course, be somewhat less variable than building averages. *When the norms for building averages are used to interpret system averages, this limitation should be recognized.* Ranks for high-scoring systems are somewhat underestimated; those for low scoring systems are somewhat overestimated.

4. Instead of using a single index (mean or median) to report achievement information for groups (classes, buildings, or total system), it is often desirable to show how achievement is *distributed*. Such a report may show the number or percent achieving at each *grade* level, or at various *percentile* levels (e.g., 0-9, 10-19, . . .) or at various *stanine levels* (e.g., 1-2-3, 4-5-6, 7-8-9). These may be

compared with similar data for the national standardization sample or with local results for previous years. Reports of this type, which may be especially appropriate for reporting to boards of education or lay groups, are illustrated in Part 4.

NORMS VS. STANDARDS

In the use of test results for instructional appraisal, it is important to recognize that a norm is only a *description of average achievement. It should not be considered as a standard* or as an indication of what constitutes "satisfactory" achievement. The average achievement in most schools varies considerably from subject to subject. It may be true, for example, that schools in general are giving much more adequate attention to the development of mathematics skills than to skills in using reference materials, and that the latter skills are being neglected even in the schools that earn relatively high averages on the Reference Materials test. In a school, then, whose average score is below average in mathematics and above average in reference materials, the need for improved instruction may, nevertheless, be more serious in reference materials than in mathematics.

In evaluating the performance of any school, many factors should be considered. A few of these are the level of aptitude of the pupils, the nature of learning opportunities outside the school, the relative emphasis placed upon the basic skills in the curriculum of the school, and the grade placement of the content taught. Such factors may account for large differences in performance between schools in the same system. They also may have an important influence upon the ranking of a school or system in comparison to the general norms. Quality of instruction is not the only determiner.

What constitutes satisfactory performance, or what is an acceptable standard, can only be determined subjectively and will differ from school to school. Each school must decide in terms of its own characteristics and objectives what may reasonably be expected of its pupils. Certainly a below average performance on a test is not necessarily an indication of poor teaching or of weaknesses in the curriculum. Examples of effective, creative teaching are to be found in many such schools. Similarly, an above average performance is not necessarily to be commended; there is considerable room for improvement in most schools (p. 26-34).

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Appendix B

Virginia's Literacy Passport Test Information

Virginia Literacy Passport Program

In 1988 the Virginia General Assembly enacted a law which put the Literacy Passport requirement into effect. In order to earn a regular high school diploma, all students must pass the Literacy Passport Test. This test consists of a battery of assessments in the following three areas: reading, writing, and mathematics. Each assessment is scored independently of the others so students can pass one, two, or all three portions of the test.

Reading Assessment

The reading portion of the literacy program is a test of reading comprehension. The Department of Education uses a special edition of the *Degrees of Reading Power (DRP)* as the literacy program's reading assessment.

The *Degrees of Reading Power* assessment is a series of tests designed to measure a students's ability to comprehend passages of varying length and degrees of difficulty. The tests determine how well students read and comprehend. Students are expected to read passages which contain blanks for missing words and fill in those blanks with appropriate word choices. Students are given several word choices from which to select. Passages for the test range from very easy to very difficult to understand. This allows for the interpretation of an individual's readability level. Readability, according to the *Degrees of Reading Power* program, is measured in *DRP* units. *DRP* units are not grade level scores and are not expressed in percentiles.

Writing Assessment

The writing assessment portion of the Virginia Literacy Testing Program is a state-developed test of writing skills. The format of the assessment requires students to read a written topic sentence or story which is used as a springboard for developing the written passage. Students are allowed to use dictionaries while working. Students may also take as much time as deemed appropriate to complete the writing task. Each student's writing sample is scored by two readers who rate students in five domains or areas including composition, style, sentence formation, usage, and mechanics.

Mathematics Assessment

The mathematics portion of the Virginia Literacy Testing Program is a state-developed test of math skills. The assessment is similar to the design and format used in the mathematics portion of the *Iowa Tests of Basic Skills*. The math assessment uses a multiple-choice format with items arranged in order of difficulty. The three components of the mathematics assessment include computation, concepts, and applications.

The Virginia Literacy Passport Program

In 1988 the Virginia General Assembly enacted a law to put the Literacy Passport requirement into effect. The Literacy Passport is a significant step in a student's education. The passport is a certificate awarded after a student has successfully completed the Virginia Literacy Passport Test. Its attainment is a sign that the student is prepared to be successful at the demanding level of secondary education.

What is the purpose of the Literacy Passport Test?

The purpose of the test is to ensure that every student in Virginia is prepared for high school in the basic areas of reading, writing, and mathematics.

What type of test is it?

The Literacy Passport Test is composed of three sections: reading, writing, and mathematics. All three parts are untimed. A student must pass all three parts in order to receive the passport. Scores on each part can range from 150 to 300. The passing score is set at 250.
The reading portion is made up of eleven 300-350 word passages, each containing seven blanks where key words have been left out. For each of

seven blanks, students must choose the one word out of the five given that makes the most sense.

For the writing test, students must compose a short essay on a specific topic that is given to them at the time of the test. The areas of composing, style, sentence formation, word usage, and mechanics are considered in scoring the essay. At least two trained readers hired by the Department of Education score each student's paper.

In the mathematics test, there are 120 multiple-choice problems involving computation and word problems. The skills measured include addition, subtraction, and multiplication of whole numbers, decimals, and fractions and division of whole numbers and decimals. Understanding of measurement and geometry are also assessed.

Who must take the Literacy Passport Test?

Since the 1989-1990 school year, the test has been given to all sixth graders in the public schools of Virginia. Students with disabilities are given equal opportunity to participate in the Literacy Passport program, and their testing needs are determined by their Individualized Education Program. However, all students who obtain a regular high school diploma must earn the Literacy Passport.

What happens if a student fails part of the test?

Once a student passes a portion of the test, he or she does not have to take that portion of the test again. Students must retake any of the Literacy Passport Tests they do not pass. Those who do not pass the tests receive special remedial help and retake the tests in grades 7 and 8. Students who have not passed all three parts by the end of grade 8 are not promoted to grade 9 but are classified as "ungraded" until all parts are passed. These students may, however, take any high school subjects for which they are eligible. Students in this category may not participate in interscholastic contests such as athletics, debate, and drama which are sponsored by the Virginia High School League. No student may receive a regular high school diploma unless all three parts of the test are passed.

When are the tests given?

All sixth grade students, those students in grade 7 and above who have not previously passed the three parts of the Literacy Passport Test, and those students in grade 7 and above who have transferred into a Virginia public school since the last time the test was given take the Literacy Passport Test in February of each school year. Those students in grade 7 and above who have not passed the three parts of the test previously and those students in grade 7 and above who have transferred into a Virginia public school since the last test administration are given an additional opportunity to take the test in October. The reading and writing portions of the test each take one day. The mathematics portion takes two days. The tests are untimed, but most students usually finish in about one hour each day.

Note. From (Draft) Virginia Literacy Passport Program by the Virginia Department of Education, 1992, Richmond, Virginia: Virginia Department of Education.

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Appendix C

Sample Student Questionnaire and Instructions

INSTRUCTIONS TO STUDENTS

Read these instructions carefully. If you need some help filling-in the Blue paper, you can ask your teacher. All answers will be marked on SIDE 1 of the Blue paper.

Where it says "NAME (Last, First, M.I.)" write in the name of your school. Then fill-in the proper letter/circle.

Where it says "SEX", fill-in the proper circle -
M -- for male (boy)   F -- for female (girl)

Where is says "GRADE", fill-in the proper circle -
4 - for 4th grade   6 - for 6th grade   11 - for 11th grade

Where is says "BIRTHDATE", write in the Day and Year you were born; then fill-in the proper circle for the Month (MO), Day, and Year (YR) you were born.

After you have filled-in the NAME of your school, SEX, GRADE, and BIRTHDATE, you can answer the questions on the other side of this paper.

Start with question 1 and mark your answers in the spaces shown on the Blue paper.

STUDENT QUESTIONNAIRE

On the Blue paper, fill-in a circle for each question.

A = Yes   B = No

1. School is a place where I feel good.
2. I would like to use a computer more.
3. Going to school can be fun.
4. I would like to have my own computer.
5. School can help in getting a job.
6. I do good work in school.
7. I feel good about my school work.
8. Teachers make me feel bad about my work.
9. I am unhappy being in school.
10. I could do better in school.
11. I like to answer questions in class.
12. Teachers care about their students.
13. I like my work on a computer.
14. The computer is hard to make work right.
15. I need more time with the computer.
16. Computers can help me get better grades.
17. Sometimes school can be interesting.
18. School is a good way to spend my time.
19. There are too many rules at school.
20. School is a waste of my time.
21. Do you have a computer at home?
22. How much time do you use a computer at school?

(Fill-in the proper circle on the Blue paper)

A = Not at all

B = Less than 30 minutes every week

C = 30 minutes to 1 hour every week

D = 1 hour to 2 hours every week

E = 2 hours or more every week

Appendix D

Sample Inventor Flash Cards

Henry Ford

Henry Ford

(1863-1947)
Henry Ford was born in Michigan in 1863 and died in 1947. Ford invented cars and was one of the first to effectively use the assembly line production. One of his most most famous model was *Model T*. He called the *Model T* the horseless carriage.

-*C. Pugh*

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Louis Pasteur

Louis Pasteur

(1822-1868)
Louis Pasteur was born in Dole, France in 1822. As a chemist and later a bacteriologist, Louis did more than any other man of his time to further medical processes. Louis Pasteur discovered the cure for a silkworm disease, for anthrax, and also for rabies.

-*T. Cobb*

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ABOUT THE AUTHOR

Charles (Chuck) Grimm -- born Aiea, Ohau, Hawaii, January 1, 1949. Dr. Grimm has authored numerous books including Mobilization, Deployment, Redeployment, and Demobilization (1992), Domestic Support Operations (1993), and Concepts of United Nations Logistics (1994), and Logistics Management of the Multi-National Operations (1990). Among his published studies include, "A Quantitative Analysis of the Special Program Requirements (SPR) Program" (1989) and "Stockage Level for Low Demand Items" (1987).

Dr. Grimm holds a Bachelor of Science degree from the University of California at San Bernardino (Business Administration), Masters of Science degrees from the University of Southern California (Adult Education) and Florida Institute of Technology (Logistics Management), as well as, a Ph.D. in Urban Services Education/Technology from Old Dominion University in Norfolk, Virginia. Dr. Grimm is a member of Phi Delta Kappa and a Senior Fellow of the United Nations Institute for Training and Research (UNITAR), Geneva, Switzerland.

Dr. Grimm has traveled extensively throughout Central and South America, Africa, and the Far East and Middle East establishing and implementing training, management, distribution, and inventory control systems. He is a graduate of the Logistic Executive Development Course, Marine Corps' Command and General Staff College, and the Army's Command and General Staff College.