

STUDENTS' PERFORMANCE ON A PAPER-MEDIATED VERSUS MULTIMEDIA  
TUTORIAL FOR LEARNING NETWORKING CONCEPTS

by

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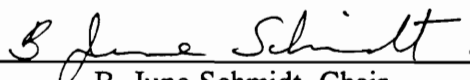
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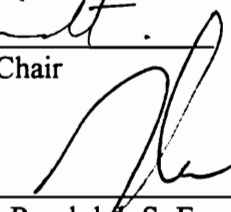
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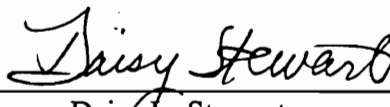
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(ABSTRACT)

This study was designed to determine the degree to which learner affective and personal characteristics affect student achievement through multimedia and paper-mediated instruction. Two research questions were examined: (a) Is there a difference in gain between pretest and posttest for the paper-mediated instruction group and the multimedia instruction group; (b) What is the effect of paper-mediated and multimedia instruction on achievement, when controlling for affective and personal characteristics? The statistical procedures used to examine the research questions were dependent t-tests and analysis of covariance.

Participants were 61 students from four classes enrolled in introductory computer classes in a high school in the Roanoke region of Virginia. The classes were randomly assigned to either a paper-mediated or multimedia treatment. Procedures involved having the participants from both groups complete five stages, either on paper or on the computer, based on group assignment. First, they completed a personal characteristics form. Second, they completed an attitude toward computers Likert-type scale, consisting of four subscales (anxiety, confidence, liking, usefulness). Third, they completed a 20-question pretest on networking terminology. Fourth, they reviewed instructional material

in either a paper or multimedia presentation form. Upon completion of the paper or multimedia computer tutorial, the participants completed a 20-item posttest on networking terminology.

Based on the results of two dependent t-tests on the pretest and posttest for each treatment group, students did realize a gain in achievement from the pretest to posttest in both groups. In testing research question two, the analysis of covariance revealed a significant treatment effect and gender as a significant covariate. Students in the paper-mediated group performed better than those in the multimedia group. Females performed higher regardless of the treatment group.

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## CHAPTER 1

### BACKGROUND OF THE PROBLEM

Multimedia instruction is not new. The term multimedia can be traced back many years to represent the use of many types of media, such as books and filmstrips.

Multimedia today means the use of computers to present material in a new way, using such elements as graphics, video, sound, text, and animation. Graves and Kupsh (1994) defined multimedia presentations as the integration, control, and manipulation of text, art and graphics, photography, animation, audio, and video. Multimedia has the capability to reach the new class of students commonly referred to as the "Nintendo generation." This generation of students grew up with the fast-paced and ever-changing television screen where, in a millisecond, they can change what they are viewing. Moreover, these students contribute to the need for new and innovative ways to reach students, ways other than the traditional, lecture-style of instruction. Multimedia is helping to provide a new avenue to reach students (Graves & Kupsh, 1994).

#### *Affective and Cognitive Barriers to Implementation of Multimedia*

Researchers have suggested that affective characteristics can affect a student's learning performance. Bloom (1976), in his theory of school learning, suggested that affective entry characteristics are one of the major factors impacting learning outcomes. These affective characteristics have been identified in the literature as anxiety, attitude, and motivation considerations, such as whether a student likes something, sees something as useful, or whether the student has personal confidence in the subject (Leso & Peck, 1992;

Banks & Havice, 1989; Bloom, 1976). Furthermore, Coorough (1991) identified anxiety as a critical learner characteristic that has strong implications for learning during Computer Assisted Instruction (CAI) and multimedia learning. A number of studies have indicated that certain levels of anxiety can be detrimental to performance in CAI (Coorough, 1991). A student's beginning level of anxiety and other affective measures (confidence, liking, and usefulness) are important factors to be considered when using multimedia.

Many factors contribute to student performance and can affect how rapidly and efficiently students learn material. Several studies have shown attitudes to be very critical in the development of a computer literate person (Simonson, Maurer, Montag-Torardi & Whitaker, 1987). Skills and knowledge are important; but due to the rapid changes in computer technology, a positive attitude toward computers is also important. If students do not have positive attitudes toward computers they will likely exhibit the following behaviors: (a) avoidance of computers and the area where they are located, (b) excessive caution when using computers, (c) negative remarks toward computers and computing, and (d) attempts to shorten periods when computers are being used (Simonson, et al., 1987).

Attitudes toward computer technology are a contributing factor in successful usage of computers and acceptance of computer technologies. One factor that affects attitudes toward computers is ability. According to Kay (1993) higher computer ability correlates significantly with attitudes toward computers—the higher the ability the more

positive the attitude. Kay (1993) also suggested that personal attitudes and applied software skills are significant predictors of home computer use. Computer ability, home computer use, and attitude affect a student's computer literacy. Fann, Lynch and Murranka (1989), further supported the idea that individuals with more computer experience have more positive attitudes toward computers than those with less computer experience.

Anxiety is another critical factor that can affect student achievement in computer-related courses. Banks and Havice (1989) suggested that undue anxiety can interfere with achievement in learning the computer and therefore on future assignments. Many researchers have subsequently supported this view point, and found that high levels of anxiety do affect a student's achievement with the computer (Leso & Peck, 1992; Campbell, 1989; McInerney, McInerney & Sinclair, 1994). These studies have also revealed a strong negative correlation with prior computer experience—the more prior experience a student has, the lower the student's anxiety level. Anxiety is well documented as a potential problem factor in learning. Other factors that contribute to students' attitudes and anxiety are their views of material as useful, confidence in material, and their liking of the material being covered. Koohang (1989) suggested that computers can help to alleviate some anxiety because computers provide an environment conducive to: informal interaction with students, absence of embarrassment, operation at the student's own pace, problem solving, tutoring, immediate feedback, and absence of subjectivity.

Prior experience with computers, a cognitive entry behavior, is a significant contributing factor to an individual's attitude and motivation toward using computers. A study involving high school students has shown that students with higher scores on computer literacy tests have a greater exposure to computer experiences (Chen, 1986). Furthermore, computer ownership allows students a greater opportunity to gain those needed computer experiences, which consequently lead to higher computer scores and more positive attitudes toward computers. According to Chen (1986) males exhibit more positive attitudes toward computers than females. However, this difference is attributed to the greater amount of computer experience and home use of computers by males. In Chen's study (1986) males, on average, used computers 6.1 hours a week versus 3.6 hours per week for females.

#### Technical Factors Affecting the Implementation of Multimedia

The market for multimedia is experiencing a \$24 billion seven-year explosion expected to peak in 1998. Most computer games on the market today implement multimedia technology. This technology will experience growth and should flourish into new ways of interacting with computers. Educators need to become aware of strengths associated with multimedia instruction and how their students can benefit from the use of multimedia technologies (Graves & Kupsh, 1994). The importance of multimedia is emphasized through its inclusion in business education curriculums. For example, the Virginia business education curriculum includes a course titled Desktop Publishing and

Multimedia. Multimedia, however, is still by and large an untapped resource in business education classrooms.

One barrier to the use of multimedia in the classroom is that it relies on an advanced level of computer technology. Since multimedia programs integrate various forms of media, a computer is needed that can process and display these different forms. The current standard for an MS-DOS computer is the MPC3 standard set by the Multimedia Personal Computer Marketing Council (MPC). The MPC3 requirements include: a Windows-based MS-DOS computer with 8 MB RAM, Pentium 75MHz processor, quad-speed CD-ROM, MIDI compatible 16-bit sound card, MPEG ready video playback capability, and a 540 MB minimum capacity hard drive (MPC, 1996). Since the majority of public schools do not have this level of technology in their business computer labs, the MPC2 standard was used as the determining factor for inclusion in this study. The MPC2 requirements include: a Windows-based MS-DOS computer with 4 MB RAM minimum, a 25MHz 486SX processor, a monitor with 65,000-color graphics with a pixel resolution of 640 by 480, a 16-bit, 44-kHz MIDI-compatible audio card, and a double-speed CD-ROM drive (Graves & Kupsh, 1994). Systems that met or exceeded these standards were selling at the time of this study for approximately \$1500. Even at this cost, and the need for computer labs of 25 or more computers, schools can find it difficult to procure the funding necessary to upgrade existing computer labs. Many schools do not have this level of technology; however, students can still benefit from the use of multimedia.

Multimedia hardware and software are relatively expensive. Computer systems considered multimedia-ready contain peripheral devices, such as CD-ROMS, that increase the cost of each computer workstation. Most schools have limited budgets and cannot afford to procure the needed level of technology to implement high-level multimedia instruction, using such elements as digitized video, sound, and advanced animation. With continual rapid change in computer technology, schools that have recently upgraded their computer equipment cannot again upgrade their computer equipment for several years. Some expense can be attributed to the multimedia software. It takes a substantial amount of time and planning to create professional multimedia programs. Further, multimedia programmers are plagued by the fear of using copyrighted material in their software and the need to obtain copyright clearance for those materials (Foley, 1993).

#### Implications for Instruction

Multimedia provides numerous opportunities to reach a diverse group of students. One of the strengths of multimedia is that it places educational control in the hands of the student and therefore individualizes the presentation of the material for each student. The student makes the decision to learn the material and in what order and at what pace. Teachers are confronted with students who learn at different speeds. Thus, multimedia instruction paced to the individual student, can help eliminate this instructional problem. According to Foley (1993), multimedia has been shown to reduce learning time by an average of 50%. This reduction in learning time can be attributed to several factors: (a) self-paced instruction encourages students to take the most efficient path to learning; (b)

the combination of media, such as graphics, text, and audio delivers the material in an easy to understand format; (c) immediate feedback provides students with a highly-effective reinforcement for learning the material; and (d) personalized instruction accommodates many different learning styles. Furthermore, multimedia can provide long-term reduced costs, instructional consistency, privacy, mastery learning, increased retention, reduced behavior problems, increased motivation, and increased access to quality instruction for all students (Foley, 1993).

Multimedia applications can be used to both remediate and enrich learning. One place that this is evident is when teachers regularly struggle with student absences and how to re-teach material to individual students who have been absent, while not neglecting the remainder of the class. Multimedia provides one method by which students can learn material that was missed with minimal teacher intervention; giving them the opportunity to catch up with the class while proceeding at their individual learning speeds. If students have computers at home, a disk containing the multimedia lessons can even be sent home so that the students will not fall as far behind.

According to Graves and Kupsh (1994), even in the age of tight economic conditions, educators must find the means for technological growth for both themselves and their students. Multimedia technology can serve as a supplemental delivery tool for instruction. The authors argue that if multimedia technology is used properly and effectively it can help to (a) engage the learning styles of the students and (b) provide interactive modes for the presentation of information.

## Rationale for the Study

Multimedia is rapidly becoming a viable option for instruction in many schools, rural and urban alike. If multimedia can be used as a supplemental instruction tool by business teachers to reach more students, then their students will benefit. Furthermore, studies have shown multimedia to be just as effective as traditional instruction in less time (Foley, 1993). However, is multimedia a better delivery method than paper-mediated instruction? With the increased costs and technical skills associated with multimedia, if paper-mediated instruction (paper tutorial) was found to be just as effective as multimedia, many hours of programming time and many dollars could be redistributed to other areas of instruction.

Anxiety as well as other affective characteristics have been identified as factors that affect student achievement. Researchers suggest that the individualized nature of tutorials can help to alleviate some of the anxiety students bring to the learning experience. Tutorials can provide students with learning experiences that eliminate fear of derogatory statements from peers, possible subjectivity of teachers, and the time pressures associated with most learning.

Many students miss important material due to absence from class. Multimedia provides one method through which the student and teacher can revisit the same lecture/class materials at a later time and receive quality instruction. It is unlikely that multimedia will replace the human teacher; but as an additional instructional tool, it can improve the academic lives of students and teachers. If teachers have learning tutorials to

backup their lectures, students can use the materials to reinforce learning at their convenience and in the privacy of their personal workstations.

The need for a single teacher to instruct growing numbers of students is painfully apparent. According to Thabede and Schmidt (1995), the demand for business teachers in Virginia schools is greatly exceeding the supply and is expected to remain that way for years to come. Virginia is not the exception regarding this potential teacher shortage. Teachers who are retiring are not being replaced in many schools, resulting in the remaining teachers teaching more students in each class. Teachers will need to use all available instructional tools at their disposal. Instructor-prepared tutorials can provide teachers with one more tool to reach the diverse group of students they are asked to instruct. Findings from this study can enlighten business teachers regarding their potential to create multimedia tutorials as supplements to their lessons, and the effectiveness of multimedia related to paper-mediated instruction.

### Research Questions

The purpose of this study is to determine the degree to which learner affective and personal characteristics affect student achievement through multimedia and paper-mediated instruction. Factors related to students' gaining computer literacy and computer skills include (a) anxiety toward the use of computers, (b) confidence in using computers, (c) liking of computers, (d) perception of the usefulness of computers, (e) prior experience, (f) gender, and (g) computer access. This study also examined whether there

are substantial differences in the level of achievement between the paper-mediated and multimedia instruction groups.

#### Research Question One.

Is there a difference between pretest and posttest scores for the paper-mediated instruction group and the multimedia instruction group?

#### Research Question Two.

What is the effect of paper-mediated and multimedia instruction on achievement, when controlling for affective and personal characteristics?

#### Delimitations and Limitations of the Study

The following delimitations and limitations apply to this study:

#### Delimitations

1. This study was delimited to high school students enrolled in introductory computer classes in a Virginia high school in the Roanoke, Virginia area.
2. The high school was further delimited by its level of computer technology. Since multimedia requires a certain level of technology to run properly, this study was limited to a school with a minimum computer setup to run multimedia. The MPC2 standard of an IBM or compatible, 486SX, 25MHz computer with, 4 megabytes RAM, Network or Hard drive, 1-3 1/2" floppy drive and running Microsoft Windows was used as the determining factor.

## Limitations

1. This study was limited by the students' interpretation and ability to organize their computer experience into five categories: No computer experience, one to four hours per week, five to nine hours per week, 10 to 15 hours per week, and more than 15 hours per week over the past year.

## Definitions of Terms

### Achievement

Achievement for this study is defined as the gain score. The gain score is computed as the difference between the pretest and posttest percentage scores.

### Anxiety

A general definition of anxiety is an affective state that may cause interference in cognitive processing during any of the three information-processing components: input, processing, and output (Coorough, 1991). A more specific definition for computer anxiety, also called computerphobia, is a fear of computers which is present among many students which can negatively influence the learning process (Koohang, 1989). For this study anxiety refers to the computer anxiety subscale score on the Attitude toward Computers instrument developed by Loyd and Gressard.

### Attitude toward Computers

"Refers to an individual's feeling about the personal and societal use of computers in appropriate ways" (Simonson, et al, 1987). For this study, attitude refers to the student's score on the Attitude toward Computers, Likert-style attitude scale instrument

designed by Loyd and Gressard at the University of Virginia (see Appendix A for the instrument).

#### Computer confidence

Confidence refers to a student's feeling of assurance in his or her ability to use computers. Computer confidence for this study is defined as the confidence subscale score from the Attitude toward Computers instrument designed by Loyd and Gressard.

#### Computer liking

Liking refers to a student's desire or enjoyment of using computers. Computer liking for this study is defined as the liking subscale score from the Attitude toward Computers instrument designed by Loyd and Gressard.

#### Computer usefulness

Usefulness refers to a student's view of the computer as an important and helpful tool for use in future school and work activities. Computer usefulness for this study is defined as the usefulness subscale score from the Attitude toward Computers instrument designed by Loyd and Gressard.

#### Instructor-prepared multimedia tutorial

Multimedia tutorial for this study is defined as the Windows-based multimedia tutorial which was designed by the researcher to teach students networking concepts. This tutorial includes interactive buttons, hypertext, graphics, text, and animation integrated together with a pretest, posttest, and attitude scale as well as an interface to obtain control data such as computer/workstation number, class period number, and

school name. This tutorial was created using the Authorware Professional (1993) multimedia authoring tool (see Appendix B for the instrument). The instructor-prepared multimedia tutorial was not designed as a professionally researched and designed multimedia tutorial; rather it was designed to simulate what a business instructor, with a limited multimedia programming background, could create.

#### Paper-mediated instruction

Refers to a paper copy of the instructor-prepared multimedia tutorial created for this study to teach networking concepts. The content of this paper tutorial is identical to the material in the instructor-prepared multimedia tutorial.

#### Prior computer experience

Refers to the amount of time an individual student has used a computer prior to this project, based on the past years' usage. This amount of experience is categorized into five levels for this study, (a) no computer experience, (b) 1-4 hours per week, (c) 5-9 hours per week, (d) 10-15 hours per week, (e) more than 15 hours per week.

#### Traditional instruction

Traditional instruction refers to instruction that includes lecture and/or discussion methodology to convey a knowledge base to students.

#### Tutorial

A tutorial is "an instructional book or program that takes the user through a prescribed sequence of steps in order to learn a product" (Freedman, 1996).

## Organization

This dissertation is organized into six chapters. Chapter 1 includes an introduction, rationale for the study, purpose of the study, delimitations, limitations, and definitions of key terms. Chapter 2 provides the theoretical framework for the study as well as the review of literature. Chapter 3 covers an overview of the design and testing of the tutorial materials. Chapter 4 consists of the research methodology, research design, data collection, and the statistics performed. Chapter 5 includes the findings of the study, and the analysis of the data in regards to the research questions. Chapter 6 summarizes the study and provides conclusions, discussion, and recommendations for instruction and further research. The references, appendices, and vita are located after Chapter 6 and provide more details regarding the study.

## CHAPTER 2

### THEORETICAL FRAMEWORK AND RELATED RESEARCH

Discussed in this chapter are the theoretical background, importance of affective factors in learning, background of multimedia, descriptions for the types of computer-assisted instruction (CAI), and research on CAI. Additionally, supporting literature for attitude toward computers with the four summated constructs (anxiety, confidence, liking, and usefulness), gender, computer access, and prior computer experience will be addressed.

In 1924 and 1925, S. L. Pressey demonstrated and discussed an early version of a teaching machine at the meetings of the American Psychological Association. This machine consisted of an apparatus that displayed multiple choice questions to a learner and, in response, the learner chose from a series of buttons to answer the questions. The learner was not allowed to proceed to the next question until the previous question was answered. This event is considered to be one of the first attempts at using computers for automated learning. Later, B. F. Skinner proposed the idea of a teaching machine that allowed learners to compose their responses to situations instead of choosing from predetermined answers. Furthermore, Skinner's machine led the learner through a series of small steps to reach the desired outcome. While Skinner did not believe that the machine or software actually taught, he saw the machine as a private tutor for students. Finally, he saw this method of instruction as an opportunity for a quality programmer to reach a large number of students (Troutner, 1991).

In 1959, Meyer described the three main steps in creating a program for an automated teaching machine. The first step was to identify what was going to be taught, facts, and objectives. The second step involved assessing the learner's prior knowledge or entry-level knowledge and skills. The third step was to arrange the facts in a logical order for presentation and testing. Today, most curriculum designers still use these basic steps, though slight modifications may be made to the process (Troutner, 1991).

Also in 1959, IBM researchers were developing applications of computers for education. They created several computer curriculums including ones for stenotyping, statistics, and German. The conclusions from IBM's researchers on these computer programs, which were mainly tutorial in nature, suggested that computer teaching was feasible (Troutner, 1991).

### Theoretical Framework

The basic theory behind Computer-Assisted Instruction (CAI) is Skinner's operant conditioning model. Skinner believed that learning should include programs of stimuli and consequences designed to lead the learner to an end result. In the 1950s, Skinner turned these ideas into an innovation called programmed instruction. Programmed instruction consisted of small written cues to the student in a predetermined sequence to prompt the students' response. It provided immediate feedback and allowed the student to work at his/her own pace. This basic design concept is the basis for most CAI programs today (Biehler & Snowman, 1990).

Although operant conditioning was the foundation for CAI programs, Piaget's work with the cognitive domain has added to the research and background for CAI development. Piaget viewed the mind as a structure which started with a foundation with subsequent levels building on the previous knowledge. In contrast to the operant conditioning model which suggests that learning is a series of stimulus and response occurrences, the cognitive model developed by Piaget suggests that individuals learn by associating new knowledge with previous knowledge. Piaget also suggested that individuals will build their own links between new and prior knowledge (Good & Brophy, 1995). Among Piagetians who stress self-regulated learning, exploration, inquiry, and discovery learning are emphasized. Self-regulated learning suggests that teachers should not teach in a prescribed manner; conversely, they should provide opportunities to explore and allow students to construct their own links and schemes for learning. Further, teachers who subscribe to self-regulated learning would foster individual instruction based on student preparedness (Good & Brophy, 1995).

Operant conditioning and cognitive development have played a role in the design and development of CAI programs; however, Bloom's (1976) theory of school learning takes into account many common variables and attempts to explain how learning is effected by these variables. Bloom's theory of school learning identifies three variables that can account for much of the variation in school learning. Bloom (1976) contended that if these three variables are properly managed schools should be able to implement a near error-free system of education. The variables are cognitive entry behaviors, affective

entry characteristics, and quality of instruction. Cognitive entry behaviors refer to the students' prior knowledge and prerequisite learning that is necessary for the learning task. The affective entry characteristics refer to the affective behaviors, such as attitude, including such things as anxiety, students' perception of the learning task, general feelings toward the task, and student motivation. The final variable is quality of instruction. Quality of instruction refers to the extent that cues, practice, and reinforcement are made appropriate to the needs of the learner. For students, these three variables interact with the learning task. The results of the learning task, influenced by the aforementioned three variables, produces learning outcomes (level and type of achievement, rate of learning, and affective outcomes). In the situation that the entry characteristics and behaviors are favorable, the learning outcomes should be at a high and positive level with little variation. Where the entry behaviors are not favorable, learning outcomes should show high variations. This theory further suggests that modifications to the behaviors: affective, cognitive, and quality of instruction can affect the learning outcomes (Bloom, 1976).

#### Research Variables

A review of the literature and theory base (theory of school learning) revealed the following variables as important to this study: prior computer experience, gender, attitude toward computers (consisting of anxiety, confidence, liking, and students' perceptions of computer usefulness), and computer access.

### Prior Computer Experience

Prior experiences with computers is a significant contributing factor to an individual's attitude and motivation toward using computers. According to Simonson, et al. (1987), students with higher scores on computer literacy tests had a greater exposure to computer experiences. Furthermore, computer ownership allowed students a greater opportunity to gain those needed computer experiences, which consequently lead to higher computer scores and better attitudes toward computers. Students prior experience with computers has also been found to affect attitudes toward computers. Lee (1986) conducted a study at the University of North Carolina at Charlotte on the effects of computer experience on computer attitudes. In the study, Lee (1986) found that past computer experience did significantly affect the performance of students in computer classroom activities. However, Lee (1986) suggested that minimal experience with computers may be sufficient to reduce computer anxiety, as no difference was found between students with high levels of experience versus those with low levels of experience. In several other studies, including high school and college students, the researchers found that levels of computer experience did affect the confidence and attitude of students using computers (Loyd & Gressard, 1984; Omar, 1992). Students with more computer experience were significantly more confident in their computer use than those with little computer experience. Since the literature identifies prior computer experience as an important factor in student attitudes toward computers and student achievement with computers, a measure of prior computer experience was chosen for this study. The

use of the variable prior computer experience is also supported by Bloom's (1976) theory of school learning which suggests that cognitive entry behaviors are an important factor affecting school learning.

### Gender

Individuals have claimed for years that gender differences exist in many facets of life. According to Fritz (1994), the American Association of University Women contended that "whether one looks at achievement scores, curriculum design, or teacher-student interaction...it is clear that sex and gender make a difference" (p. 1). Fritz (1994) conducted research on the learning styles of males and females with interesting results. The study consisted of 144 subjects, 62 males and 82 females, enrolled in Georgia high school marketing education programs. The subjects' learning styles were examined resulting in males being found to be more field-independent and females more field-dependent. Individuals exhibiting field-independent styles tend to be internally focused, hypothesis driven, and more interested in abstract courses, such as math and technology. Field-dependent individuals tend to be externally focused, people oriented, and more interested in programs that emphasize social information, such as home economics and social studies. Fritz (1994) suggested that these differences could affect achievement when tasks are complex and demanding. Hattie (1990) also claimed that males feel more in control when using a computer and deal better with adverse situations regarding the computer if they arise. Furthermore, Fritz (1994) suggested that males and females seem to have different hierarchies in their learning style preferences, which "could affect the

selective attention and enduring motivation that each gender brings to a situation" (p. 15). Since these differences exist, a variety of informational formats may be needed for all individuals to fully understand new abstractions (Fritz, 1994).

In 1986, Chen conducted a study of gender differences in computer use and attitudes. This study included 1,126 high school students, 595 males and 531 females. According to Chen (1986), although males did exhibit more positive attitudes toward computers than females, this difference was largely attributed to the greater amount of computer experience and home use of computers by males. Chen identified that males, on average, used computers 6.1 hours a week versus females who used computers an average of 3.6 hours per week. Chen (1986) further hypothesized that the lack of female interest in voluntary computer experiences could be due to social influences. Further, based on the results of five Computerphobia studies involving over 450 California State University students, Rosen, Sears, and Weil (1987) concluded that women had more negative attitudes toward computers than males.

#### Attitude toward Computers

The role of computers in schools and society is expanding, requiring schools to offer students a variety of exposures to computer use. A person's attitude toward computers can have an impact on whether the person will use computers in school or daily life. Lewis (1992) suggested that a negative attitude toward technology or computers is a barrier to computer use in the classroom, by both teacher and student. Loyd and Gressard (1984) supported the importance of attitudes toward computers as a factor in

determining the success or failure of new computer programs. Attitudes are complex behaviors consisting of multiple constructs. According to Simonson, et al., (1987), individuals' attitudes toward computers refer to their feelings about the personal and societal use of computers in appropriate ways. In other words, an individual's attitude refers to that persons' likes or dislikes. Loyd and Gressard, at the University of Virginia, have done extensive research into people's attitudes toward computers. They developed the Likert-scale attitude measure used in this study. Loyd and Gressard began examining attitudes toward computers in the 1980s and developed several attitude scales. To build support as they developed their attitude scales, Loyd and Gressard conducted research involving 155 eighth- through twelfth-grade students. The purpose of the study was to provide information about the factorial validity and reliability of their attitude scales. Through this research these individuals established the validity and reliability of the Attitude toward Computers scale, which consisted of 40 Likert-scale statements broken into four separate constructs, with 10 questions for each. The composite sum of the four separate constructs equaled the composite attitude score. The four sub-scales or constructs are: (a) anxiety or fear of computers, (b) liking of computers, (c) confidence in ability to use or learn computers, and (d) views of computers as useful tools (Loyd & Gressard, 1984).

The Attitude toward Computers instrument used in this study was tested by Loyd and Gressard (1984) on 155 students, 51 males and 104 females, in grades 8 through 12, with ages ranging from 13 to 18, who were enrolled in a computer-based education class.

The reported coefficient alpha reliabilities for the sub-scales were all .86 or higher and .95 for the total score. Through their study of the validity and reliability of several computer aptitude and attitude scales, Roszkowski, Devlin, Snelbecker, Aiken, and Jacobsohn (1988) concluded that the Loyd and Gressard's scale was a valid and reliable instrument.

The importance of attitude toward computers and its impact on success with computers is supported by research. Further, importance of two subscale constructs of anxiety and confidence are supported by the literature. Although the other two subscale constructs, liking and usefulness, are not specifically supported in the literature, studies have shown liking and usefulness to be related to computer experience (Koohang, 1989). Therefore, the four subscales, representing the four separate constructs in the Attitude toward Computers scale, developed by Loyd and Gressard at the University of Virginia, were chosen as variables to be examined in this study.

Anxiety. Anxiety is a well documented psychological characteristic that can cause individuals to be slightly afraid or extremely fearful of something, which is commonly referred to as a phobia (Biehler & Snowman, 1990). Anxiety towards computers is often called computerphobia. Computerphobia, according to Koohang (1989), is the fear of computers and is present in many students. Koohang (1989) also notes that students can develop a level of computerphobia that can negatively affect learning. Koohang (1989) conducted research on 81 college-level students and examined the correlations among computer anxiety, confidence, liking, and perceptions of computer usefulness. Other researchers have also concluded that anxiety is a factor that can negatively affect computer

learning (Leso & Peck, 1992; Campbell, 1989; McInerney, McInerney & Sinclair, 1994; Coorough, 1991). For example, Campbell (1989) conducted a study of 1,067 students in rural schools in Oklahoma. The students ranged from grades five to twelve, with only 8% of the sample taken from grades five to six. The study found that home computer access and anxiety did affect student learning. Additionally, the research involving 101 first year undergraduate education students conducted by McInerney, et al. (1994) supports anxiety as a factor in achievement. Since anxiety is a recognized affective characteristic that can affect student learning, this specific construct was examined in this study.

Confidence. As previously noted, an individual's attitude toward computers can greatly affect his or her achievement with computers. Loyd and Gressard (1984) identified four specific constructs, including confidence, that together define an individual's attitude toward computers. While literature on attitudes does apply to the confidence construct, since it is part of the whole, some researchers have specifically identified it as an important factor. Fisher (1989) suggested that students need to feel power and confidence in using computers and have direct access to computers to develop a high feeling of empowerment and control. He further suggested that these feelings are vital to student success with computers. Bloom (1976), in his theory of school learning, further supported the need for affective entry characteristics, such as low anxiety, positive attitudes, confidence, liking, and interest, as well as cognitive entry behaviors such as prior knowledge and experience with computers.

Liking. The need for liking in a student's attitude is simple and relates to motivation. If a student likes the learning task, then that student has an intrinsic motivation to complete the task. If the student does not like the learning task, or has a fear of the task, then the student will not be motivated to complete the task. This need is supported by behaviorists such as Skinner (Biehler & Snowman, 1990) as well as the theory of school learning proposed by Bloom (1976). Further, in the creation and validation of the Attitude Toward Computers scale developed by Loyd and Gressard (1984), they identified liking as one of four constructs that affect student acceptance of computer technology.

Usefulness. As with the construct liking, usefulness relates to motivational concerns. If students perceive that computers are useful tools and that they will benefit in their future jobs or schooling from using computers, then they are much more likely to have an intrinsic motivation to work with computers and to have a more positive attitude toward that use. Conversely, if students see the use of computers as a waste of time and cannot comprehend when they would use computers outside of the classroom, they are much more likely to have no motivation toward the use of computers and, therefore, have a negative attitude toward their use. They may even have an aversion to computers. Once again the basic foundations of behaviorism, in such work as Skinner's operant conditioning models (Biehler & Snowman, 1990), and the theory of school learning by Bloom (1976) support the importance of such affective motivational factors as liking and feelings of computers as useful tools. In the creation and validation of the Attitude

Toward Computers scale developed by Loyd and Gressard (1984), they identified perceptions of usefulness as one of four constructs that affect student acceptance of computer technology.

### Computer Access and Ownership

Students' access to a computer at home can be vital in development of attitudes toward computers and later success with computers. In a study by McCormick and Ross (1990), computer access and computer experience were found to be strong predictors of computer interest. In a study conducted by Harrington, McElroy, and Morrow (1990), similar results were found. They examined computer access and computer experience as predictors of computer anxiety. In another study with ninth and tenth grade students, Tierney (1989) concluded that students greatly improved their critical thinking skills over a two-year period of having high access to computers. Further, better organization of papers, inclusion of graphics, and advanced planning skills were cited as benefits of student access to computers. Students also need to feel that they are in control of their learning, termed empowerment. The level of computer access that a student has directly affects that student's feeling of empowerment. In an exploratory study of two fourth grade classrooms, Fisher (1989) concluded that students in an environment with high access to computers have stronger feelings of empowerment. Finally, computer ownership was identified as a vital factor to student success with computers because it allowed students a greater opportunity to gain the needed computer experiences, identified as a critical need in Bloom's theory of school learning as a cognitive entry behavior (prior

knowledge), which consequently leads to higher computer scores and better attitudes toward computers (Simonson, et al., 1987).

### Computer-Assisted Instruction (CAI)

As computer technology has advanced, computer-assisted instruction (CAI) enhanced through multimedia has become widely used in education. CAI is broadly defined as using a computer to teach and includes such subcategories as drill and practice, tutorial, and simulation instructional methods (Venezky & Osin, 1991). There are many different definitions for multimedia. According to McCarthy (1989), interactive multimedia is "the integration of text, audio, graphics, still images, and moving pictures into a single, computer-controlled, multimedia product" (p. 26). Others define multimedia presentations as including the integration, control, and manipulation of text, art and graphics, photography, animation, audio, and video for presentations (Kupsh, 1995). Both definitions appear to include the essential elements: graphics, text, audio, video, and animation.

Multimedia tools can provide individual, active, and flexible learning. These tools can reach many of the senses through the use of audio and visual stimuli. In addition, multimedia encourages the use of multiple human senses, such as hearing and seeing, and provides the learner flexibility in his or her individual learning process. Individual control is fostered in multimedia instruction. Additionally, students develop a sense of ownership as they direct their own learning and become more interested in learning as they create their own paths toward knowledge acquisition. Technology provides students with

flexible learning time, different learning opportunities, and the potential for individual learning plans (Damyanovich, Copa, & Pease, 1992). According to Blattner and Dannenberg (1992) the primary goal of multimedia is to provide better communication. People communicate through multiple means, such as gestures, voice, and written communication; therefore, multimedia systems attempt to communicate information to a user through various types of media (Blattner & Dannenberg, 1992).

During the late 1980s and early 1990s, five types of CAI were categorized. These included drill and practice, tutorial, problem-solving software, instructional games, and simulation. Geisert and Futrell (1995) described these five types as follows.

1. Drill and practice programs are primarily for refining an existing skill. Drill and practice instructional software is similar to the old flash cards, used primarily in elementary school, where the students were presented with information, via the flash card, and then asked to repeat what they have learned.

2. A tutorial program is similar to a one-on-one tutoring session. Tutorials are primarily used for presenting new information. Tutorials can be very effective in delivering new knowledge to learners.

3. Problem-solving software involves higher-order thinking skills. This type of software often leads learners into open-ended, puzzle-oriented situations that require higher-order thinking skills to complete.

4. Instructional games have been highly motivating for students. The fun nature of this type of program can be motivating for students. Instructional games often mimic such games as "Jeopardy," which involve answering questions to receive a reward.

5. Simulation CAI is designed around an environment in which the learner is placed to perform an activity. For example, a student learning about navigation would be placed in a simulated water environment, such as a lake, and given the navigation tools to sail a boat around. As the student makes decisions in the program, the boat is moved accordingly. Simulations provide a tool for effective instruction. Examples include dangerous situations, such as a chemistry experiment, or when the true environment, such as sailing a boat on a lake, is not available.

#### Research on CAI

Computer-assisted instruction has been around in various forms for a number of years. A large pool of early research on CAI is available and has been combined in the form of meta-analysis studies. The meta-analysis studies offer a better look at the overall research in CAI due to their cumulative nature. For this literature review, meta-analysis studies were examined regarding CAI effectiveness, time savings, and cost-effectiveness.

#### CAI and Traditional Instruction

CAI effectiveness, when examined against traditional instruction, has been a continuing area for research. Guthrie and McPherson (1992) identified CAI as an effective supplemental instructional tool at the college level. Furthermore, Guthrie and McPherson's (1992) study revealed that 71% of the subjects used the CAI materials when

their use was optional. According to Roblyer, Castine, and King (1988) meta-analysis studies on CAI effectiveness have indicated that tutorial CAI was found to be significantly more effective than other forms of CAI and that locally-developed materials resulted in better achievement than commercially available materials. Furthermore, this meta-analysis led to the conclusion that using tutorial CAI yielded slightly higher effect sizes overall than studies using drill and practice (Roblyer, Castine & King, 1988). The type of CAI used at various learning levels was also examined and resulted in conclusions that drill and practice CAI worked better with lower-level skills found at lower grade levels, such as elementary school, and tutorial CAI worked better with higher grade students, such as those in high school. The success of the type of CAI is dependent on the type of skill being taught and instructional strategy being employed. Kulik and Kulik (1987) and Bangert-Drowns, Kulik, and Kulik (1985) further supported these claims of CAI effectiveness in their meta-analysis studies concluding that: (a) students generally learned more when they received help from computers, (b) students learned material in a shorter time frame, an average reduction of 32%, and (c) students liked their classes and had a more positive attitude toward computers after learning through CAI methods. Findings from studies in the meta-analysis indicated that CAI is more effective as a supplement to instruction than a replacement for instruction. Finally, CAI appears to be more effective at lower grade levels and with younger ages than college levels and for adults (Roblyer, Castine & King, 1988). For this study, a locally-developed, instructor-prepared tutorial

was chosen as the instructional tool for teaching high school students computer networking terminology.

### Time Studies

In the meta-analysis studies regarding time issues related to CAI, eight studies at various grade levels, including K-12, College, and Adult Education, led to the conclusion that computer-based treatments yielded significantly shorter learning times. The average time savings was 32%. The studies examined were mostly at higher grade levels, including high school and college (Roblyer, Castine & King, 1988; Kulik & Kulik, 1987; Bangert-Drowns, Kulik & Kulik, 1985).

### Summary

In the expanse of research on CAI, a number of factors have been identified that may affect learner outcomes. These factors include anxiety, confidence with computers, liking computers, perceptions of computer usefulness, gender, computer access or ownership, and prior computer experience. Further research is needed to examine the impact of these factors on student outcomes when learners use CAI provided through instructor-prepared multimedia programs. Additionally, the theoretical foundations of CAI were examined with emphasis on the theory of school learning proposed by Bloom (1976) and its application to multimedia tutorial instruction. As teachers become aware of the factors and theoretical foundations related to the effectiveness of instructor-prepared CAI, they can determine ways that multimedia can be used beneficially in their own classrooms.

## CHAPTER 3

### TUTORIAL DESIGN

The multimedia and paper-mediated tutorials used in this study were created by the researcher. The tutorials were created to assist teachers in the instruction of networking concepts. Many teachers are required to teach increasing numbers of students in introductory computer classes, as schools are opting to not hire additional or replace retiring teachers (Thabede & Schmidt, 1995). This reduction in staff problem is contributing to the need for teachers to be able to reach more students with the same content in the same time frame. Further, teachers are regularly faced with the problem of truant students and mixed ability levels. When a student is absent, it is very difficult for a teacher to remediate that student without neglecting the remainder of the class. Some students learn faster than others. These tutorials are an attempt to find other useful tools for teachers to use to combat these conditions. If instructor-prepared tutorials can assist teachers in covering content, then the teachers can use these tutorials to help them reach more students on an individualized basis, and thus draw nearer to the error-free system of education described by Bloom (1976) in his theory of school learning. With greater amounts of information to teach each year, tutorials can help teachers by providing a tool to assist them in teaching or reteaching content.

Students can benefit from using the tutorials prepared for this study. It is intended to increase their knowledge about local area network technology and to allow the students an avenue for relearning material without their teacher's intervention or direction and

without fear or anxiety of peer knowledge of their remediation. To meet the demands of today's work world, students need this knowledge. As more companies install local area networks, a student's basic computer background must expand to include knowledge about networking. Instructor-prepared tutorials with graphics, text, and animation (multimedia-only) can assist the teacher in covering the necessary material.

### Instructional Objectives of the Tutorials

In the design of the tutorials the following instructional objectives were identified.

After completion of the networking tutorials, the student will be able to:

1. Identify key networking concepts and terminology.
2. Identify the four main networking topologies (star, ring, bus, and daisy-chain).
3. Differentiate between collision detection networks and token-ring networks.
4. Identify the four main communications channels used to connect networks (twisted-pair, coaxial, fiber, wireless).
5. Map how a file transfers from one computer to another in a local area network (LAN).
6. Identify the main reasons for using local area networks.
7. Differentiate between local area networks and wide area networks.
8. Identify the main parts of a network.

### Preliminary Design and Programming of the Multimedia Tutorial

After the instructional objectives were identified, the programming of the multimedia tutorial began. Reference materials covering the content area, networking concepts, were gathered and examined, including a high school telecommunications book titled, *Telecommunications: Concepts and Applications* (Cubbler, Olivo, & Scrogan, 1992). Key terminology was identified and recorded. The multimedia tutorial was programmed with the Authorware Professional 2.0.1 (1993) multimedia authoring software. Eleven key terms, as identified in the networking chapter of the aforementioned telecommunications text, and several related terms were then selected based on the objectives of the tutorial. The main menu of the tutorial consisted of the eleven key terms. The menu displayed the eleven terms, in white text, representing hypertext links to other material in the tutorial. The students had the option to select any item in any order, allowing them freedom over their navigation; however, they were required to explore (select) all the terms before they were allowed to exit. Words that had not been selected could be identified by the cursor changing to a pointing finger icon. When a menu item was selected, the student was taken to another screen, or series of screens, explaining the main concept. Most information screens consisted of a textual definition/explanation and graphical representation of the term. The definitions were written by the author with reference given to the high school telecommunications text for the reading level of the wording. The graphics used in the displays were either created by the author or in the public domain. After completion of the information screens, the students returned to the

main menu. After all the terms had been selected, an exit button appeared on the display. When the exit button was selected, the students were shown a textual list of justifications for using local area networks and then allowed to exit the tutorial. Navigation and control features were accomplished through assigning of values to variables.

### Acquisition of Affective and Cognitive Data

After the tutorial was checked and corrected for grammar and technical errors by several instructors of introductory computer courses in Virginia high schools, thought shifted to how test and attitude data would be collected and recorded. The author decided to collect demographic data and scores for the pretest and posttest and attitude subscales via computer for the multimedia group. The paper group completed all of the parts on paper. This was done to smooth the flow from one part of the study to another. Multimedia group students would not be required to fill out several paper and pencil tests and then shift to the computer to complete the tutorial and then return to the paper and pencil test. Using this procedure, one program could be loaded onto student computers or the class network and completed by the students with little or no teacher or investigator interaction. Furthermore, the computers could record each student's scores in an ASCII file, which was later used in data analysis.

### Multimedia group design

The 40-item attitude scale, consisting of the four separate constructs, was programmed into the program along with the pretest and posttest. The pretest and posttest measures contained identical test items, which were placed in a different order for

the two tests. This was done to reduce the test/retest bias. A copy of the posttest appears in Appendix C. Mathematical computations were included to provide the students with immediate feedback as to their performance on the pretest and posttest. Upon completion of a test, the student's score was computed, recorded in the ASCII file, and displayed on the monitor. Control data such as computer number, class period number, school name, amount of prior computer experience, gender, and computer ownership were also gathered and recorded to the individual student's ASCII file. The filename for the ASCII file was a concatenation of the computer number and the class period number to maintain anonymity and confidentiality. The order for the program was: (a) introduction screen, (b) collection of demographic data, (c) attitude subscales, (d) pretest, (e) tutorial content/instructional module, (f) posttest, and (g) thank you screen. After all the sections of the complete project application were created, the program and corresponding testing modules were examined and debugged by the author. One college faculty member was then used to test the program. Several minor formatting and navigation errors were identified and corrected. Upon determination that the tutorial was ready for initial field testing, a local high school computer teacher was contacted and a pilot test was conducted.

#### Paper-mediated group design

The paper group students received identical, paper copies of all of the measures included in the multimedia program. These measures included personal characteristics data collection forms (see Appendix D for the instrument), attitude scale, pretest, tutorial

packet, and posttest. Upon completion of the pretest and posttest measures in the multimedia group, the students were immediately shown their scores. The paper-mediated group received no feedback on their tests. Content identical to the multimedia tutorial was made available to the paper-mediated group. However, the paper copy of the tutorial could not include the network topology animations and did not include color. The materials for the two groups, paper and multimedia, were identical except for the presentation medium used and the lack of color in the paper-mediated materials.

#### Multimedia pilot test one

The first of two pilot tests on the multimedia tutorial was performed with a small morning section of an introductory computer class in a suburban high school in the Roanoke region of Virginia, which consisted of eight students. The program was loaded onto the computers and upon entering the class the students were asked to voluntarily participate in the study. The students agreed to participate and were then asked to read the computer screen and navigate the program as directed through their computers. The students completed the entire program in an average of 45 to 50 minutes, which conformed nicely to the 50 minute class period. Students were then asked to complete a short evaluation form regarding their experience. It appears in Appendix E. The written evaluation sheets and computer-collected data were analyzed.

The tests and evaluation sheets identified a need for more graphics. An item analysis and cluster report for the pretest and posttest showed that a majority of the student responses did not cluster around the correct answers. The material and test

questions covering the problem areas were examined and revised. A number of the questions had two answers with an even split between the responses. The test item choices were modified in an attempt to reduce the duplicate possibility. The tutorial content related to the other test items which had very scattered responses was examined. One content problem area was the classification of network topologies. The material covering the three main types of network topologies was presented on one page with small graphics and text. The page contained too much material and was separated into one page for each topology with larger graphics and animations added. The written formative evaluation sheets, completed by the students, showed that the students generally thought that the program was easy to navigate. Further, they felt that they understood the material presented and found that they did not get lost. In their opinion the length of the program was right. Several students did suggest that more graphics be added to clarify the information. Finally, a Cronbach's alpha reliability estimate of .97 was computed for the attitude scale for the eight students. This reliability estimate conformed to the published reliability of .95 for this instrument.

With these suggestions and this data in hand, the tutorial was modified. The content was clarified and graphics and animations were added. Several test questions were reviewed and the choices modified to remove the possibility of a second correct answer. The navigation controls in several areas of the tutorial were slightly modified to clarify and simplify confusing navigation points. After modifications were made, grammar

checked, and the program debugged, a larger pilot test using students from four introductory computer classes at the same suburban high school was conducted.

### Multimedia pilot test two

The second pilot test on the program was conducted with a total of 40 students, enrolled in two morning and two afternoon sections of an introductory computer class in a suburban high school in the Roanoke region of Virginia. The tutorial program was loaded onto the computers and upon entering the class the students were asked to voluntarily participate in the study. The students agreed to participate and were then asked to read the computer screen and navigate the program as directed by the computer. The students completed the program in an average of 45 to 50 minutes. Students were then asked to complete the same short evaluation form regarding the tutorial as students in the first pilot test. The written evaluation sheets and computer-collected data were analyzed.

The tests and evaluation sheets of the 40 pilot-test subjects revealed no problems with the tutorial, as shown in the data in Table 1. An item analysis and cluster report for the pretest and posttest indicated that the majority of the student responses did cluster around the correct answer. A dependent t-test analysis was performed on the pretest and posttest scores to determine if the students learned anything from the tutorial. The t-test showed a statistically significant  $t$  (11.69) with a probability of,  $p=.00$ . A test analysis was performed on the posttest measure, which consequently revealed a Cronbach's alpha reliability estimate of .72. The item analysis showed satisfactory item intercorrelation.

The satisfactory item intercorrelations and satisfactory reliability estimate suggest that the posttest measurement is a consistent measure.

The written formative evaluation forms were examined and found to strongly support all aspects of the program including ease of navigation, use of graphics, clarity, and length of the tutorial, see Table 1. During the implementation of the pilot test, only one spelling error and one minor navigation error (due to an incorrect variable value) were identified and subsequently corrected. A Cronbach's alpha reliability estimate was figured for the attitude scale and produced a reliability of .97. This reliability estimate of .97 conformed to the published reliability of .95 for this instrument. Finally, a formative evaluation on the content and useability of the tutorial was performed by four computer instructors who taught introductory computer classes in Virginia high schools. The instructors generally found the program to be useful and the content to be correct.

#### Paper pilot test

The third pilot test, conducted on the paper-mediated instruction instrument, was performed with a total of 14 students, enrolled in a morning section of an introductory computer class in a Rockingham County (Virginia) high school. The paper-mediated instruction consisted of paper versions of the personal characteristic data collection sheet, attitude scale, pretest, tutorial, and posttest. Upon entering the classroom, the students were asked to voluntarily participate in the study. The students then received the personal characteristics data collection sheet. After completing this form, they were instructed to raise their hands to receive the next form. This process continued until the students had

completed the tutorial and all data collection forms. The students completed the program in an average of 30 minutes. Students were then asked to complete a short evaluation form regarding the tutorial. The written tests and evaluation forms were then compiled and analyzed.

The tests and evaluation sheets of the 14 pilot-test subjects revealed no problems with the tutorial, as shown in the data in Table 2. A dependent t-test analysis was performed on the pretest and posttest scores to determine if the students learned anything from the tutorial. the t-test showed a statistically significant  $t (9.55)$  with a probability of,  $p=.00$ .

The written formative evaluation forms were examined and found to strongly support all aspects of the program including clarity of directions, use of graphics, clarity, and length of the tutorial, see Table 2. A Cronbach's alpha reliability estimate was figured for the attitude scale and produced a reliability of .94. This reliability estimate of .94 conformed to the published reliability of .95 for this instrument.

Table 1

Summary of Formative Evaluation Responses—Multimedia second pilot test

Question	% responses
1) Was the interface user-friendly and easy to navigate? YES NO	YES=97.5% NO=2.5%
2) Did you understand the information/definitions? YES NO	YES=75% NO=25%
3) Did you need clearer definitions/information? YES NO	YES=30% NO=70%
4) Did you need more graphics to understand the material? YES NO	YES=30% NO=70%
5) Did you ever get LOST in the program? YES NO	YES=20% NO=80%
6) Did you feel that the time required to finish the program was (circle one):	a) Too long= 12.5% b) Too short= 2.5% c) Just right= 85.0%

Table 2

Summary of Formative Evaluation Responses—Paper pilot test

Question	% responses
1) Did you understand the paper tutorial directions? YES NO	YES=86% NO=14%
2) Did you understand the information/definitions? YES NO	YES=93% NO=7%
3) Did you need clearer definitions/information? YES NO	YES=14% NO=86%
4) Did you need more graphics to understand the material? YES NO	YES=7% NO=93%
5) Did the information keep your interest? YES NO	YES=79% NO=21%
6) Did you feel that the time required to finish the program was (circle one):	a) Too long= 0% b) Too short= 7% c) Just right= 93%

## Summary

This chapter covered the development and testing of the paper-mediated and multimedia tutorials used in this study. Issues of reliability regarding all of the instruments that were included were addressed. Reliability estimates indicated that all of the instruments were consistent measures. Further, formative evaluation of the tutorials revealed that they were easy to use, easy to navigate, and generally informative. Sufficient details regarding the tutorials were included so that other researchers could replicate this study. The tutorial content screens are located in Appendix B.

## CHAPTER 4

### RESEARCH METHODOLOGY

The purpose of this study was to determine the degree to which learner affective and personal characteristics affect student achievement through multimedia and paper-mediated instruction. Factors related to students' gaining computer literacy and computer skills included (a) anxiety toward the use of computers, (b) confidence in using computers, (c) liking of computers, (d) perception of the usefulness of computers, (e) prior experience, (f) gender, and (g) computer access. This study also examined whether there are substantial differences in the level of achievement between the paper-mediated and multimedia instruction groups.

#### Research questions

To meet the purposes of the study, two research questions were addressed.

##### Research Question One.

Is there a difference between pretest and posttest scores for the paper-mediated instruction group and the multimedia instruction group?

##### Research Question Two.

What is the effect of paper-mediated and multimedia instruction on achievement, when controlling for affective and personal characteristics?

#### Description of Participants

Subjects for the study were students enrolled in four introductory computer classes in a Virginia high school. The high school was located in a suburban area of Roanoke,

Virginia. For the purposes of identification, Table 3 displays specific attributes related to the school district and student population used in this study. Two intact classes from a morning section and two from an afternoon section of an introduction to computers course were randomly assigned the paper-mediated instruction or the multimedia instruction.

Appropriate sample size has been the focus of long standing debate. In determining sample size, factors such as power, alpha, and effect size must be considered. According to Pedhazur and Schmelkin (1991) the most frequently used guidelines for effect size are those of Cohen, who suggested the levels of .2 for a small effect size, .5 for medium, and .8 for a large effect size. For this study a power of .80, effect size of .20, and an alpha of .05 were chosen for determining sample size. Using the sample selection tables created by Hinkle, Oliver, and Hinkle (1985) and the aforementioned values for power, alpha, and effect size an ideal sample of 50 subjects were identified as appropriate to this study. A total of 61 students in 4 classes were chosen for this study. The students were in grades 9 through 12.

Additionally, the sample school was chosen based on availability and level of computer technology in the school. Since multimedia requires a certain level of technology to run properly, this study was delimited to a school with computers that could run the multimedia program. The MPC2 standard of an MS-DOS, 486SX, 25Mhz, 4 megabytes RAM, network or hard drive, 1-3 1/2" floppy drive computer running Microsoft Windows was used to delimit the school for this study.

Table 3

**School District and Student Attributes**

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Percent of 12th grade students who completed a class including keyboarding or typing <sup>a</sup>	100%
Pupil/teacher ratio <sup>a</sup>	9.4
State per-pupil expenditure <sup>b</sup>	\$5,202
Local per-pupil expenditure <sup>b</sup>	\$2,800
Instructional personnel per 1000 students <sup>b</sup>	73.1
SES (% of students with approved applications for free or reduced lunch) <sup>a</sup>	17%
Percentage of high school graduates who earned Advanced Diplomas <sup>a</sup>	47%
<b>Locality attributes</b>	
Total population <sup>b</sup>	24,036
Poverty level (% families below federal poverty level) <sup>a</sup>	3%
Median Adjusted gross income <sup>a</sup>	\$21,157

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<sup>a</sup> Obtained from the 1996 Virginia Summary Report.

<sup>b</sup> Obtained from the 1994-95 Superintendent's Annual Report for Virginia.

## Data Collection

The data collection method for the multimedia instruction group was automated and included in the multimedia program. The data collection method for the paper-mediated group consisted of paper and pencil versions of the same instruments in the multimedia tutorial.

The data collection began with directions to the students regarding the purpose of the study and general directions needed for them to start on the computer or the first paper handout. For the multimedia group, the program began with a statement of consent to participate, after which control data questions were asked, such as class period, computer number, school name, and morning or afternoon class. The student responses to these questions were recorded in an individual American Standard Code for Information Interchange (ASCII) file. After these data were collected, the students were asked two questions. The first question was "Do you have access to a computer outside of school?" The second question asked to the students was, "On average, how often have you been using computers over the past year?" The students could choose from five selections, ranging in hours from no experience to more than 15 hours per week of experience. The responses to these questions were recorded in the student's ASCII file.

The paper-mediated group completed the same control questions on paper by circling their responses to the questions. The questions and response choices were identical to the multimedia group questions. Control numbers, consisting of period and computer numbers, were used to keep track of the control data. Upon completion of the

control data collection, the students were instructed to raise their hands to receive the next section.

After the control data were collected the students were guided through the four subscales (anxiety, confidence, liking, and usefulness) of the Attitude toward Computers, 40-item, Likert-scale instrument developed by Loyd and Gressard (1984) at the University of Virginia. The instrument appears in Appendix A. For the multimedia group, the students were shown a statement regarding their attitude toward computers and were asked to select from four buttons, strongly agree, slightly agree, slightly disagree, and strongly disagree. The individual responses were recorded in the students' ASCII file as well as their four subscale scores. The paper-mediated group scores were recorded on their individual test sheets. All items that were reverse-coded were recoded by the computer before being stored in the student's ASCII file. However, the paper-mediated group responses were recoded by the researcher. The attitude scale developed by Loyd and Gressard was not modified in any way for this study, except to be configured as an on-line, interactive test for the multimedia group. According to Loyd and Gressard (1984) the coefficient alpha reliability estimate of the attitude scale was reported as .95 for the total score and .86 or higher for each of the subscales, representing high reliabilities. Their study involved 155 subjects in grades eight through twelve. Since the attitude scale was being administered in a slightly different way in this study, three pilot tests were conducted. The first two pilot tests were conducted on the multimedia tutorial. The third pilot was conducted on the paper-mediated tutorial. The first pilot test, with eight high

school students, resulted in a coefficient alpha reliability estimate of .97, which conformed to the prior reported reliability of .95. The second pilot test, with 40 students, resulted in a coefficient alpha reliability estimate of .97. The third pilot test, involving the paper group, with 14 students, resulted in a coefficient alpha reliability estimate of .94. These estimates also conformed with the reported reliability of .95.

After the students completed the 40-item attitude scale they were presented a pretest to complete which covered their knowledge of networking concepts. The pretest consisted of 20 multiple-choice items drawn from a pool of items created by the researcher. Each item had four possible answers. Individual responses and percentage scores were recorded in the student's appropriate ASCII file. Responses from the paper-mediated group were recorded on individual test sheets that were graded by the researcher. After the paper-mediated group students completed the pretest they raised their hands to receive the next section. A test analysis was performed on the pilot study subject responses to examine item intercorrelations and reliability. The results of the test analysis showed a Cronbach's alpha reliability estimate of .72 for the posttest and satisfactory item intercorrelations, ranging from .20 to .67. Finally, the individual items on the test were answered correctly by 30% to 82% of the examinees.

In a series of testing memos, by the Virginia Tech Measurement and Research Services office, a good test is identified as one with item-intercorrelations of .20 or better, .50 or better reliability estimate (for shorter tests), and the percentage of correctly answered items between 30% and 80% (Frary, 1994). The data from the researcher's test

analysis, completed by the Measurement and Research Services office at Virginia Tech, conform to the published standards for a good test.

Upon completion of the pretest, the multimedia group was presented with the multimedia tutorial. It consisted of a primary menu of items which were linked to corresponding information. The tutorial allowed the students to select items from the primary menu in any order, based on their preference. Even though the students had the freedom to choose the items in any sequence, they were still required to complete all the items in the tutorial before the program would allow them to exit. The construction of the tutorial includes interactive buttons, hypertext links, graphics, text, and simple animations. Sound was not included in the tutorial due to the limited number of computers in high schools equipped with sound cards and speakers or headphones. The navigation screens for the tutorial can be seen in Appendix B. The completion time for the multimedia tutorial averaged 25 to 35 minutes.

After completing the pretest, the paper-mediated group was given a paper version of the multimedia tutorial screens. The tutorial screens were identical in content and use of graphics. The paper-mediated version of the tutorial could not include the animations that were a part of the network topology explanation screens in the multimedia tutorial. The students were presented with a paper packet. The first page was an index of the topics and page numbers. This page is consistent with the main menu screen in the multimedia tutorial. Students had the option to choose a topic and go to that page or read the entire material in a linear progression. An informal observation by the researcher

during the paper group pilot test revealed that most of the students proceeded through the paper tutorial packet in a linear progression—one page at a time in sequence. Upon completion of the paper material, the students were instructed to raise their hands so that they could receive the posttest measure.

After completing the learning tutorial, the students were presented with a 20-item posttest, covering the material in the tutorial. The posttest was constructed of the pretest items, arranged in a different order to lessen the test-retest bias. The students' individual question responses and percentage scores were recorded in their appropriate ASCII files. The posttests for the paper-mediated and multimedia groups were identical. The only difference between the groups on the posttest was the way that the test was administered, paper-mediated received a paper test, and multimedia received a computer-based test. For the multimedia group, after the scores were recorded the tutorial displayed a thank you message to the students and returned them to the Program Manager in Microsoft Windows.

#### Data Analysis

After all the subjects in the study had completed the multimedia program or paper-mediated tutorial, the resulting ASCII file contents and paper-recorded results were compiled and inserted into Number Cruncher, Series 5.x (1992), a statistical software package, for analysis. The statistical procedures used to analyze the data for each of the two research questions are presented below.

### Analysis of gain scores

Is there a difference between pretest and posttest scores for the paper-mediated instruction group and the multimedia instruction group?

Percentage scores on the pretest and posttest measures for both groups were obtained. The two different groups of paired pretest and posttest scores were compared using dependent t-tests of significance.

### Analysis of affective and demographic factors related to gain scores

What is the effect of paper-mediated and multimedia instruction on achievement, when controlling for affective and personal characteristics?

Achievement scores for the two groups were obtained as the difference between pretest and posttest percentage scores (gain scores). With gain scores as the dependent variables, Analysis of Covariance (ANCOVA) was used to examine the relationship between the achievement of the two groups with affective and personal characteristics included as covariates. The covariates in this model included students' anxiety scores, computer confidence scores, computer liking scores, computer usefulness scores, gender, five levels of prior computer experience, and yes/no responses to computer access. Interaction effects were also examined to determine the extent to which the covariates contribute to the total variance between the two experimental groups.

Table 4

Analysis of Covariance Variables

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Variables

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Dependent

Achievement (paper-mediated)<sup>a</sup>

Achievement (multimedia)<sup>a</sup>

Independent (covariates)

Anxiety<sup>a</sup>

Confidence<sup>a</sup>

Liking<sup>a</sup>

Usefulness<sup>a</sup>

Gender

Male=0

Female=1

Prior Experience<sup>a</sup>

No Computer Experience=1

1-4 hours per week=2

5-9 hours per week=3

10-15 hours per week=4

More than 15 hours per week=5

Computer Access

Have access to a computer outside of school=1

No access to a computer outside of school=0

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<sup>a</sup> These are continuous variables.

## Summary

In this chapter, the research design, sample selection procedures, learning process procedures, statistical analysis methods, and data collection methods were described. Further, school district and student attributes information was provided for the school that served as the setting for the study. Students from four sections of an introduction to computers course participated by completing either the paper-mediated or the multimedia tutorial. For the first research question, dependent t-tests were computed to compare students' performance on the pretest with their performance on the posttest. For the second research question, analysis of covariance was used to compare performance of the two groups, paper-mediated and multimedia, taking into account the pretest scores and selected demographic control variables. Chapter five will address the findings.

## CHAPTER 5

### FINDINGS OF THE STUDY

The purpose of this study was to determine the degree to which learner affective and personal characteristics affect student achievement through multimedia and paper-mediated instruction. Factors related to students' gaining computer literacy and computer skills included (a) anxiety toward the use of computers, (b) confidence in using computers, (c) liking of computers, (d) perception of the usefulness of computers, (e) prior experience, (f) gender, and (g) computer access. This study also examined whether there were substantial differences in the level of achievement between the paper-mediated and multimedia instruction groups. The preceding chapter explained the research design, sample, data collection, and data analysis procedures. The results of the study are presented in this chapter.

The experiment took place with 61 students enrolled in introductory computer classes at a high school in the Roanoke region of Virginia. All of the 61 students in the four sections (two morning and two afternoon), of an introductory computer course voluntarily participated in the study. The four classes were randomly assigned to treatment groups. Periods two and seven were assigned to the paper group; while periods three and five were assigned to the multimedia group. These random groupings produced a paper-mediated group of 33 subjects and a multimedia group of 28 subjects.

The four groups supplied all information and completed the treatment tutorial, pretest and posttest in the same order. The students in the paper-mediated group could

browse through all of the questions on the test at one time. However, the multimedia group could only see the questions one at a time and could not change an answer after completing a question. The first measure was a collection of personal data, second an attitude scale, third a pretest, fourth the tutorial (either paper or computer version), and finally the posttest. The measures were identical except for the method of presentation (i.e., computer versions for the multimedia group and paper versions for the paper-mediated group). Both groups completed the materials in about the same time, approximately 40 to 50 minutes.

#### Attitude Reliability

To ensure the reliability of the four subscales of the attitude scale, a correlation coefficient was calculated for the anxiety, confidence, usefulness, and liking subscales of the attitude toward computers instrument. Cronbach's Alpha was used to calculate the internal consistency of the four subscales. These reliability coefficients, displayed in Table 5, ranged from .82 to .89. Cronbach's Alpha was used to figure the internal consistency of the entire instrument (all four subscales). A reliability coefficient of .95 was found for the entire instrument. These reliabilities are very similar to those identified by Loyd and Gressard (1984), in the validation of their instrument, which were reported as .86 or higher for the subscales and .95 for the total score.

Table 5

Reliability Estimates for Attitude Subscales

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Subscale	Reliability Coefficient
Anxiety	.88
Confidence	.88
Liking	.89
Usefulness	.82
Overall	.95

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## Analysis of Data

After collecting and analyzing the raw data in Number Cruncher, Series 5.x (1992), a statistical software package, answers to the following research questions were explored:

1. Is there a difference between pretest and posttest scores for the paper-mediated instruction group and the multimedia instruction group?
2. What is the effect of paper-mediated and multimedia instruction on achievement, when controlling for affective and personal characteristics?

The percentage scores from the pretest and posttest measures were obtained for the paper-mediated and multimedia groups. Pretest scores ranged from 10% to 65% for both the paper-mediated and multimedia groups. The means for these groups on the pretest did vary, the paper-mediated group had a mean of 41.7% while the multimedia group had a mean of 35.2%. Posttest scores ranged from 20% to 100% for the paper-mediated group with a mean of 76.2%. The multimedia group posttest scores ranged from 15% to 95% with a mean of 59.8%. Table 6 displays the descriptive statistics for the pretests, posttests, and gain scores. The paired percentage scores were then compared using dependent t-tests of significance. The paper-mediated group was found to have a statistically significant gain score,  $t=13.3$ , with a probability of  $p=.00$ . The multimedia group obtained a statistically significant gain score,  $t=6.9$ , with a probability of  $p=.00$ . The mean gain score for the two groups were paper-mediated group=34.6%, an increase of almost 7 out of 20 test questions, and the multimedia group=24.6%, an increase of almost 5 out of 20 test questions.

Table 6

Percentage Pretest, Posttest, and Gain Score Descriptive Statistics

	Min. %	Max. %	Mean %	SD %
Pretest Paper-mediated	10	65	41.7	15.7
Pretest Multimedia	10	65	35.2	13.4
Posttest Paper-mediated	20	100	76.2	19.5
Posttest Multimedia	15	95	59.8	23.9
Gain Paper-mediated	5	75	34.6	14.9
Gain Multimedia	-25	50	24.6	18.9

Additional mean scores for the two groups are summarized in Table 7. These means were slightly lower, with standard deviations slightly higher than those reported by Roszkowski, et al. (1988). The research by Roszkowski, et al. (1988), conducted with 42 experienced teachers, reported means and standard deviations as follows: anxiety,  $M=36.9$  with a  $SD=3.8$ ; confidence,  $M=37.2$  with a  $SD=3.0$ ; Liking,  $M=37.1$  with a  $SD=3.1$ ; Usefulness,  $M=37.9$  with a  $SD=2.2$ . The interpretation of the affective scores suggests that the students in the study had low anxiety, high confidence, strong liking, and viewed computers as useful tools. The anxiety measure is reverse scored; a high score represents low anxiety. Overall, the scores suggested that the students had high positive attitudes toward computers.

#### Analysis of Covariance

To answer research question two, analysis of covariance was performed with the gain scores of the two groups as the response variables and the seven variables (anxiety, confidence, liking, usefulness, gender, experience, and computer access) as covariates in the analysis model. The F-ratio of 4.85 was significant beyond the .05 level. The two variables that resulted in a significant relationship are group,  $p=.03$ ; and gender,  $p=.009$ . Mean scores for gender separated by group are identified in Table 8. All other covariates did not significantly affect the model. The between-group variance, identified as group, was significant. Table 9 provides the details regarding the analysis of covariance results. After the analysis of covariance revealed a significant between groups F-ratio, a post-hoc comparison was made.

Table 7

Summary Statistics for Study Variables

Variable	Paper-mediated Group N=33		Multimedia Group N=28	
	Mean	SD	Mean	SD
Anxiety <sup>a</sup>	34.4 <sup>b</sup>	5.5	34.0	6.3
Confidence	33.0 <sup>b</sup>	5.6	31.2	5.9
Liking	30.9 <sup>b</sup>	6.6	30.6	6.6
Usefulness	35.3 <sup>b</sup>	4.2	34.3	5.2
Experience	2.7 <sup>c</sup>	1.1	2.4	.9
Gain	34.6 <sup>d</sup>	14.9	24.6	18.9

<sup>a</sup> The higher the number the lower the anxiety level

<sup>b</sup> Actual score on a possible range of 10 to 40

<sup>c</sup> Actual rating on a possible range of 1 to 5

<sup>d</sup> Difference between pretest and posttest percentage gain

Table 8

Percentage Gain Score Statistics by Gender Group

Gender	Paper-mediated Group			Multimedia Group		
	N	Mean	SD	N	Mean	SD
Female	19	37.4	16.5	16	30.3	14.0
Male	14	30.7	12.1	12	17.1	22.4

Table 9

Summary Table for Analysis of Covariance

Source	<i>df</i>	Mean Squares	<i>F</i>	Probability
Anxiety <sup>a</sup>	1	.9	0.00	.954
Confidence <sup>a</sup>	1	9.1	.03	.854
Liking <sup>a</sup>	1	340.0	1.28	.263
Usefulness <sup>a</sup>	1	36.9	.14	.711
Gender <sup>a</sup>	1	1973.7	7.45	.009 <sup>b</sup>
Experience <sup>a</sup>	1	12.8	.05	.827
Access <sup>a</sup>	1	142.0	.54	.468
Group	1	1284.9	4.85	.032 <sup>b</sup>
Error	52	265.0		
Total	60			

<sup>a</sup> denotes a covariate

<sup>b</sup> significant at the .05 level

Fisher's LSD Comparison report was conducted and the resulting report confirmed that the paper and computer groups were statistically different based on gain scores. Adjusted mean scores are presented in Table 10. Further analysis of the adjusted mean scores suggested that the realized gain, in number of questions on the test correct, was approximately seven questions for the paper-mediated group, and 5 for the multimedia group. When mean gain scores by gender were compared, results indicated that female students answered approximately 1.5 more questions correctly than males in the paper-mediated group and approximately 2.5 more questions correctly than males for in the multimedia group.

Eta squares ( $\eta^2$ ) were computed with the sums of squares for group (between group variance) and gender to determine the amount of variance explained in each group. Eta squared is a ratio of the sums of squares for the individual variables over the total sums of squares and is similar to  $R^2$  in regression analysis. The result for group was  $\eta^2 = .07$ , or 7% of the total variance can be explained by the treatment. The result for gender was  $\eta^2 = .11$ , or 11% of the total variance can be explained by gender.

Table 10

Adjusted Means and Standard Errors for Percentage Gain Scores by Group

	N	Mean	Std. Error
All	61	29.6	
Paper-mediated Group	33	34.7	2.83
Multimedia Group	28	24.5	3.08

## Summary

A total of 61 respondents provided data for statistical analysis. The affective measure subscales' reliability was substantial,  $r = .82$  to  $r = .89$ , with the composite reliability,  $r = .95$ . Dependent t-tests on the pretests and posttests for both the paper-mediated and multimedia groups showed significant gains in achievement. However, the analysis of covariance showed that there was a statistically significant difference between the paper-mediated group's gain scores and those of the multimedia group. The paper-mediated group had a significantly higher mean gain score. The only covariate that was significant was gender. Females had a higher gain score than males in the study. All other covariates did not significantly contribute to the analysis of covariance model.

## CHAPTER 6

### SUMMARY, CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

#### Summary

For this study, high school students' achievement on paper-mediated versus multimedia learning tutorials was compared. This chapter provides a summary of the study, procedures, findings, discussion, conclusions, and recommendations for instruction and further research.

#### Statement of the Problem

The purpose of this study was to determine the degree to which learner affective and personal characteristics affect student achievement through multimedia and paper-mediated instruction. Factors related to students' gaining computer literacy and computer skills included (a) anxiety toward the use of computers, (b) confidence in using computers, (c) liking of computers, (d) perception of the usefulness of computers, (e) prior experience, (f) gender, and (g) computer access. This study also examined whether there are substantial differences in the level of achievement between the paper-mediated and multimedia instruction groups.

#### The Sample

The population of interest was introductory computer classes in Virginia high schools. From the total population, one high school in the Roanoke region of Virginia was selected based on availability to be included in the study. Four introductory computer classes in the school were randomly assigned to the two treatment groups, paper-mediated

and multimedia instruction. Both groups completed the similar materials in the same amount of time, an average of 40 to 50 minutes.

### Instrumentation

The instruments consisted of personal characteristics questions, an attitude scale (containing four subscales), a pretest, the tutorial (paper or computer), and a posttest. The personal characteristics included student control number, morning or afternoon class, school name, gender, access to computers question, and a self-assessment of prior computer experience.

The attitude toward computers survey instrument, containing the four subscales included in this study, was created by Loyd and Gressard (1995) and was not modified for this study. The survey was included in computer format for the multimedia group. The results of the survey produced four subscale scores, anxiety, confidence, usefulness, and liking, each with a range of 10 to 40 points. The composite of the four scales constituted the total attitude score. The four subscale scores were used in the data analysis.

The pretest and posttest measures were created by the researcher. The two tests were identical measures except for the order of the questions which was changed between the pretest and posttest to reduce test-retest bias. The paper-mediated group received a paper version of the multiple choice test. The computer group (multimedia) received a computer version of the test. The students in the paper-mediated group could browse through all of the questions on the test at one time. However, the multimedia group could

only see the questions one at a time and could not change an answer after completing a question.

### Data Collection and Analysis

The four classes at the high school were randomly assigned to treatments. Each class received a brief explanation as to the purpose of the research. The individual students were asked to voluntarily participate in the study, and all 61 students agreed to participate. The paper-mediated group was handed individual components of the testing procedure. First they received the personal characteristics sheet, then as students finished they were instructed to raise their hands at which time they were handed the pretest. The multimedia group, however, completed all of the testing in a linear fashion through the computer. The computer program was used to collect the personal characteristics, attitude scale, pretest, and posttest data. Minimal student-teacher interaction occurred with the multimedia group. Multimedia group data was stored in individual ASCII files and printed for analysis. Gender, computer access, and prior computer experience were dummy coded to allow for inclusion in the data analysis. All paper-mediated tests were hand scored by the researcher and entered into the computer for data analysis.

### Findings

Two research questions served as a framework for reviewing the findings of the study.

1. Is there a difference between pretest and posttest scores for the paper-mediated instruction group and the multimedia instruction group?

2. What is the effect of paper-mediated and multimedia instruction on achievement, when controlling for affective and personal characteristics?

Dependent t-tests were performed on the pretest and posttest scores for the two treatment groups. The results showed a significant  $t = 13.3$  with a probability of  $p = .00$  for the paper-mediated group and a significant  $t = 6.9$  with a probability of  $p = .00$  for the multimedia group. The t-tests were two-tailed tests with a level of significance of  $\alpha = .05$ .

Using analysis of covariance, the effect of the treatment difference between gain scores and control groups was statistically significant. Between group variance was statistically significant at the .05 level, with an F-ratio = 4.85 and a  $p = .03$ . Based on the adjusted means, the paper-mediated group realized a greater gain score (mean = 34.7%) than the multimedia group (mean = 24.5%). The only covariate to display significance was gender. The covariate gender yielded an F-ratio = 7.45 with a  $p = .009$ . Based on mean gain scores, female students realized a greater gain than male students.

Eta squares ( $\eta^2$ ) were computed with the sums of squares for group (between group variance) and gender to determine the amount of variance explained in each group. The result for group was  $\eta^2 = .07$ , or 7% of the total variance can be explained by the treatment. The result for gender was  $\eta^2 = .11$ , or 11% of the total variance can be explained by gender.

## Conclusions

The purpose of this study was to determine the degree to which learner affective and personal characteristics affect student achievement through multimedia and paper-mediated instruction. Analysis of covariance was used to identify the factors that affected student achievement.

The study was performed at a high school in the Roanoke region of Virginia. Four introductory computer classes were chosen and randomly assigned to the paper-mediated or multimedia treatment groups. A total of 61 students were included in the study. Generalization of the results of this study can only be made to the extent that other subjects would resemble the ones in this study. Further, the findings of the analyses used to answer the research questions were not in agreement with findings of prior studies. Therefore, the following conclusions should be cautiously received until they can be strengthened with further research and replication of this study.

1. The type of treatment or instruction, paper-mediated or multimedia, does affect student achievement. Therefore, caution should be taken in implementing multimedia throughout the curriculum. Educators should be careful not to look at multimedia as a replacement for traditional instruction. Further, teachers should consider creating paper-mediated tutorial materials before committing the time and energy resources needed to create instructor-prepared multimedia tutorials that depend on the knowledge and use of an authoring language. Teachers would likely be more productive by creating their instructional materials with a user-friendly computer application that can manipulate

graphics such as a word processing or presentation graphics program. Students did obtain significant gain scores in both groups; however, students in the paper-mediated treatment realized higher gain scores. Multimedia should not be discarded as a supplemental instructional tool; however, caution should be taken when implementing multimedia into the curriculum to assure that it is not being used solely because it is a new and interesting technology.

2. The gender of the student does affect student achievement regardless of the treatment. This study does not support the findings of prior research. Female students realized higher gain scores than male students regardless of the treatment. The only conclusion that the researcher will draw is that female students performed better than male students for this study. If additional research supports this finding, it could mean a fundamental change in current knowledge regarding gender inequalities.

3. Anxiety, confidence, liking, usefulness, experience, and computer access did not affect student achievement when they used paper-mediated or multimedia tutorials. These results do not support the findings of previous studies. If these findings are supported with additional research, they could mean a change in the factors that have been viewed as important in predicting student learning when using computers. If these factors are no longer of the greatest importance, research should focus on what other factors do affect achievement.

## Discussion

Discussion about this study centers around the affective and cognitive characteristics and their impact on learning through paper-mediated or multimedia tutorials. Previous studies such as Coorough (1991) and Simonson, et al. (1987) suggested that such affective factors as anxiety and such cognitive factors as prior experience affect learning computer technologies. However, outcomes of this study revealed that only two factors, gender and treatment, affected the gain in achievement after completing a tutorial. The paper-mediated group showed a greater gain in achievement from the pretest to posttest than the multimedia group. Several explanations for this finding follow.

In a study on the effects of computer-assisted instruction on anxiety in first-year undergraduate accounting students, Hurt and Olfman (1992) found that student performance dropped when learning through CAI and found high levels of anxiety after the students completed the learning. The students' anxiety in the multimedia group could have been raised by having to complete the instructional materials on the computer, which is different than the traditional method of learning. Though a measure of anxiety toward computers was taken prior to the students' completing the multimedia tutorial and found not to be significant, no post-anxiety measure was taken to determine if the CAI instruction caused anxiety in the students and therefore affected their achievement.

Students are more comfortable and accustomed to learning through paper and pencil and classroom lecture methods. The students may have been more comfortable

using the paper-mediated materials, since they are familiar with learning in this manner. This feeling of comfort could have resulted in the paper-mediated group performing at a significantly higher level.

The students in the paper-mediated group received the pretest and posttest measures in their complete form. This form allowed the students to compare questions to look for patterns or clues to the correct answer. The researcher noticed some students performing this activity during the data collection. Although the test questions were created to reduce the possibility of formulating correct answers from other questions, students may have been able to find clues that were enough to trigger their memory and thus increase their achievement scores. Conversely, the multimedia group received one question at a time on the screen and could not go back to change their answers once a question was answered.

Finally, the students in the paper-mediated group received more teacher attention than the computer group. This interaction was unavoidable for this study. The paper-mediated group students were required to raise their hand for each section of the study. If teacher interaction added to the motivation of students, the motivation could have caused the students to try harder on the test of achievement.

Gender was the only other variable to yield significant values. Gender was identified by several researchers including Chen (1986), Fritz (1994) and Hattie (1990) as a factor affecting student achievement and attitude in general computer use. According to Chen (1986), although males did exhibit more positive attitudes toward computers than

females, this difference was largely attributed to the greater amount of computer experience and home use of computers by males. Chen identified that males, on average, used computers 6.1 hours a week versus females who used computers an average of 3.6 hours per week. The results of this study were contrary to previous research, showing that female students realized higher gains in achievement than males regardless of the treatment, prior experience, and attitude. Female students realized higher gain scores in both the paper-mediated group and the multimedia group. One explanation for this difference could be that the female students were more motivated and interested in participating in the study. During the data collection, the researcher observed that the female students appeared to be more interested in the activities and more focused on the testing than the male students. Though this was a purely informal observation of the students, it could help to explain some of the difference between the students.

### Recommendations

The findings and conclusions of this study indicate that certain variables such as type of treatment and gender affect student achievement on paper-mediated and multimedia tutorial learning. Further, anxiety, confidence, usefulness, liking, experience, and computer access do not affect student achievement. The conclusions are used to support the following recommendations for instruction and further research.

#### Recommendations for Instruction

The basic research in cognition supports the idea that multimedia presentations should be highly effective instructional tools (Hooper, 1986). In the descriptive research

by Lewis (1992) into the emerging computer-based educational technologies and their potential relevance to vocational education, several implications for the use of computers in vocational instruction were suggested including, (a) self-paced instruction, (b) student-teacher interaction across vast distances, (c) development of inspectable and manipulable abstract models of complex devices, (d) experiences in hazardous situations through simulations, (e) approximations of human one-to-one tutoring can be offered, and (f) students can access and manipulate rich varieties of multimedia reference materials. This study does not support the use of a multimedia tutorial over a paper-mediated tutorial and suggests that in at least some settings paper-mediated tutorials may be more effective than instructor-prepared multimedia tutorials. A review of the descriptive data, and the results of the dependent t-tests, revealed that the multimedia group did obtain significant gain scores, increasing on average approximately five questions on the posttest; however, the paper-mediated group increased seven questions on the posttest. Based on this study, it is recommended that teachers not use multimedia just because it is the current trend in educational technology.

#### Recommendations for Further Research

Since the findings of this study do not support previous research, additional research is needed to support these findings. Several recommendations for additional research are identified below to substantiate the findings of this study.

1. Replication should take place with higher level computer students, such as those in desktop publishing and multimedia courses. These students have more computer

experience and may have adjusted to obtaining information from computer screens enough to adopt to multimedia learning. While prior computer experience was not significant in this study, other research studies have supported the importance of prior computer experience.

2. Replication should take place with schools in different localities and larger sample sizes and should take place with different subject areas and content, such as history or science. This study used a small group of students in an introductory computer course in one school. Therefore, a larger and more diverse group of students should be examined due to differing entry level behaviors.

3. Based on the availability of multimedia products, replication should take place with paper handouts versus professionally designed and tested multimedia instruments.

Bloom's (1976) theory of school learning includes quality of instruction as a critical factor in learning. Professionally developed multimedia tutorials are created by a group of experts over a substantial period of time. Therefore, professionally developed tutorials could provide a higher quality of instruction and produce higher achievement than the instructor-prepared multimedia tutorial used in this study.

4. Studies should be conducted to determine what factors affect learning to account for the error variance found in the statistical analyses in this study. A total of only 18% of the variance was explained by the two significant variables, gender, and treatment effect. Therefore, further research should be conducted to determine the factors that account for the remaining variance.

5. Replication of this study should be done with modifications to the testing procedures. The pretest and posttest in the multimedia tutorial should be revised to allow students to return to previous questions to change answers or allow students to see the entire test. In this study the paper-mediated group may have been able to obtain clues from other test questions, since the students could see all the test questions at one glance. Therefore, the change in the multimedia testing procedures could better equate the two test groups on pretest and posttest scores.
6. Replication should take place with different computer content areas. The area used in this study was networking. This topic may not have been appropriate for multimedia instruction. Therefore, different content in the tutorial might allow for different student achievement.
7. Studies should be conducted to identify students that may perform better with multimedia. Factors such as learning styles that can affect student achievement were not examined in this study. Other factors such as anxiety, confidence, liking, usefulness, experience, and computer access have been identified by prior research as important for student achievement. However, for this study, these factors were not significant. Therefore, further research should be conducted to determine factors that do affect student achievement with multimedia.
8. Based on the availability of advanced hardware in the schools, replication should take place with paper handouts versus a more technologically-oriented instructor-prepared multimedia tutorial. This tutorial should contain audio, more advanced animations, and

video clips as appropriate for the content. The instructor-prepared tutorial used in this study contained only simple animations and did not include video or audio. Since some students are more audio- or visual-oriented, a more advanced tutorial could reach more diverse students.

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**APPENDIX A:**  
**ATTITUDE TOWARD COMPUTERS SURVEY**  
(with permission, by: Loyd and Gressard, 1995)

## ATTITUDE TOWARD COMPUTERS (Loyd and Gressard)

Strongly Agree

Slightly Agree

Slightly Disagree

Strongly Disagree

1. Computers do not scare me at all.
2. I'm no good with computers.
3. I would like working with computers.
4. I will use computers many ways in my life.
5. Working with a computer would make me very nervous.
6. Generally I would feel OK about trying a new problem on the computer.
7. The challenge of solving problems with computers does not appeal to me.
8. Learning about computers is a waste of time.
9. I do not feel threatened when others talk about computers.
10. I don't think I would do advanced computer work.
11. I think working with computers would be enjoyable and stimulating.
12. Learning about computers is worthwhile.
13. I feel aggressive and hostile toward computers.
14. I am sure I could do work with computers.
15. Figuring out computer problems does not appeal to me.
16. I'll need a firm mastery of computers for my future work.
17. It wouldn't bother me at all to take computer courses.
18. I'm not the type to do well with computers.
19. When there is a problem with a computer run that I can't immediately solve, I would stick with it until I have the answer.
20. I expect to have little use for computers in my daily life.
21. Computers make me feel uncomfortable.
22. I am sure I could learn a computer language.
23. I don't understand how some people can spend so much time working with computers and seem to enjoy it.
24. I can't think of any way that I will use computers in my career.
25. I would feel at ease in a computer class.
26. I think using a computer would be very hard for me.
27. Once I start to work with the computer, I would find it hard to stop.
28. Knowing how to work with computers will increase my job possibilities.
29. I get a sinking feeling when I think of trying to use a computer.
30. I could get good grades in computer courses.
31. I will do as little work with computers as possible.
32. Anything that a computer can be used for, I can do just as well some other way.
33. I would feel comfortable working with a computer.
34. I do not think I could handle a computer course.
35. If a problem is left unsolved in a computer class, I would continue to think about it afterward.
36. It is important to me to do well in computer classes.
37. Computers make me feel uneasy and confused.
38. I have a lot of self-confidence when it comes to working with computers.
39. I do not enjoy talking with others about computers.
40. Working with computers will not be important to me in my life's work.

**APPENDIX B:  
TUTORIAL NAVIGATION SCREENS**



Display:

## Network Terminology and General Information

Please read through the following information.

Network (p. 2)	WANs (p. 5)
Network Operating System (p. 8)	Server (p. 6)
Ethernet ( p. 4)	Workstation (p. 7)
Topology (p. 11-16)	Gateway (p.10)
Communications Channels (p. 17-21)	LANs (p. 3)
Bridge (p. 9)	Justification (p. 22)

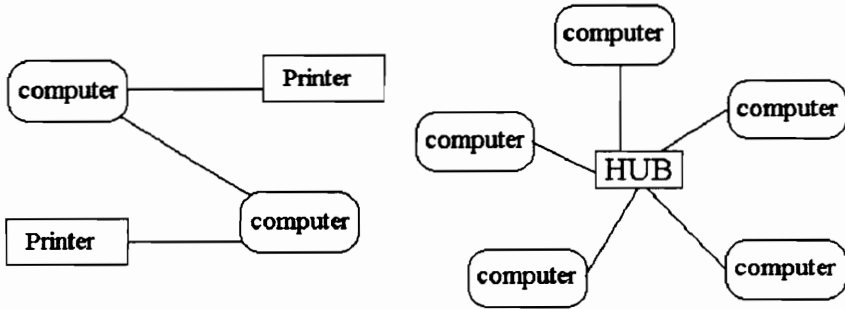
When you have completed reading the material,  
Please raise your hand.



Display:

### *Network:*

A network is an interconnection of two or more computers or computer peripherals. A computer peripheral is any device connected to a computer, like a printer. Displayed below are two examples of networks.



lans

Display:

### *Local Area Network [LAN]:*

Local Area Network: A data communications network covering a limited distance (a few miles at most). Networks allow users to share disks, printers, communications, and other devices, as well as files. LAN's are the "traditional" computer network found in most businesses and school computer labs.



Display:

## *Ethernet:*

Ethernet is a cable and access protocol scheme developed by Xerox that uses a carrier-sense multiple access media access control scheme [CSMA]. Traditionally these networks communicate at 10 million bits per second and use twisted-pair or coaxial cable. Ethernet is one of the most popular LANs in use.

Ethernet networks communicate like a phone in your house. If you pick up the phone and start talking, but someone is already talking then a collision occurs, which causes you to stop, put down the phone and retry later.



WANS

Display:

### *Wide Area Network [WANs]:*

Wide Area Networks are data communications networks that cover large geographic areas, generally hundreds of miles between cities and other countries. The nationwide telephone network, the Internet and large multinational company networks are good examples.

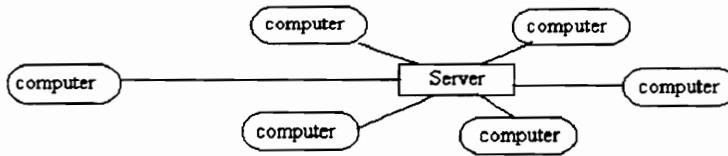


server

Display:

### *Server:*

A server is a computer that provides specific operations to a local area network. Examples of servers include: **File**, **Print**, and **Communication** servers. A file server's main purpose is to store and provide access to data files. Print servers act as a middleman between computers on the network and the printers attached to the network. Communication servers connect all of the computers in the Local Area Network to outside sources, via fax/modem capabilities or Wide Area Network access.

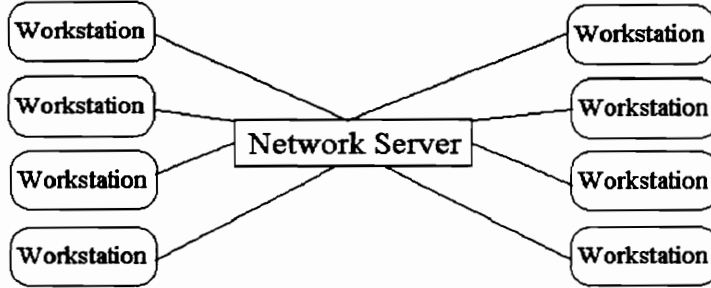


Workstation

Display:

*Workstation:*

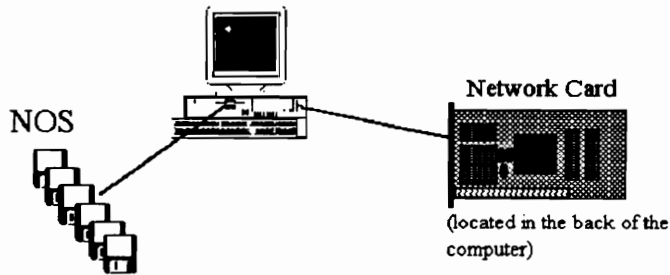
A workstation (also called a station or a node) is a computer that is attached to the network and communicates with the main computer called the network server. A network server is almost never used as a workstation.



Display:

## *Network Operating System [NOS]:*

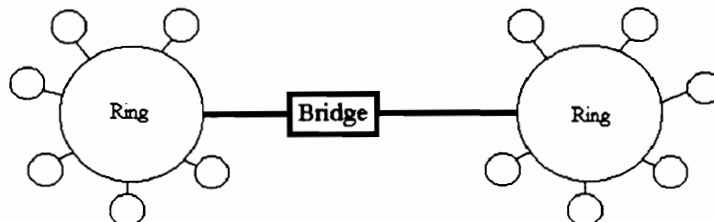
The **NOS** is the **SOFTWARE** side of a LAN, a NOS is the program that controls the operations of a network. A NOS enables the user to communicate and to share files and peripherals. It provides the interface to the LAN, and it communicates with the LAN hardware or network adapter card.



Display:

### *Bridge:*

A bridge is a device that links two Local Area Networks of the **SAME** type together. For example linking two ring networks to make one larger network.



**Bridges connect SIMILAR networks!!**

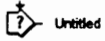
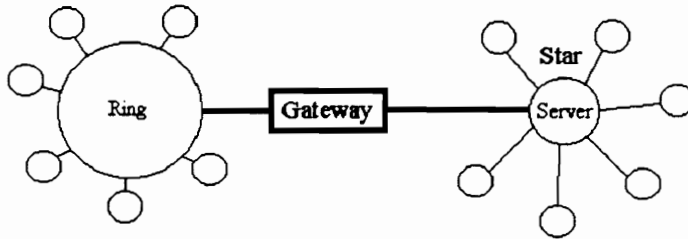


Gateway

Display:

### *Gateway:*

A gateway is similar to a bridge, but a gateway connects two **DIFFERENT** networks. For example, connecting a ring and a star network. Connecting a company's local area network to the internet would require a gateway. The example below is connecting a Ring network with a Star network.



Display:

## *Topology:*

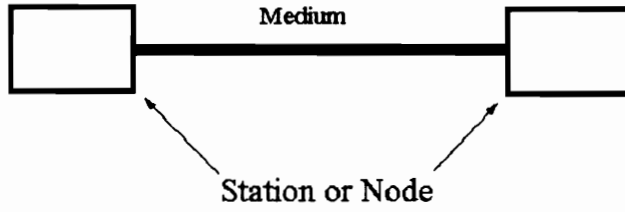
Topology refers to the map or physical layout of a network and how the wires or cabling are laid out. It identifies how the data will flow through the network. The simplest type of topology is point-to-point, which only connects two stations. Another topology is called multi-point. Several examples of multi-point topologies are: Star, Ring, Bus, and daisy-chain.



point-to-point

Display:

### Point-to-Point Topology



Display:

## MULTI-POINT topologies include:

### STAR

A Star network consists of a central Hub or server with **all computers connected to that central computer**. This is the **most common** of all Network Topologies.

### RING

A Ring network is made up of many computers linked together without a central Hub. This topology most often uses a Token-Passing technology to send and receive data. Which means that a computer can only send and receive data when it holds the imaginary electronic token.

### BUS

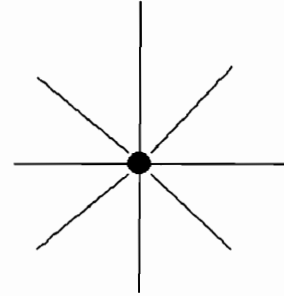
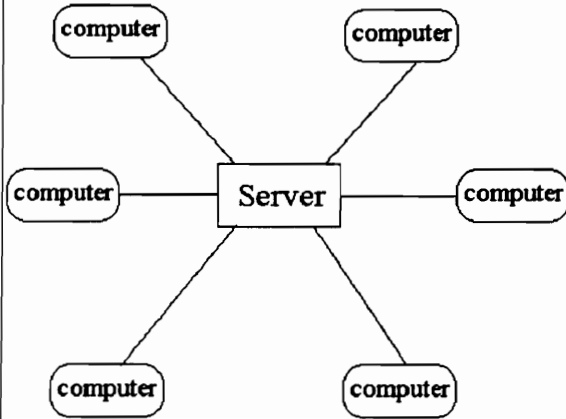
A Bus topology is made up of a series of computers that are linked to a central communications channel called a "Backbone".



Star network graphics

Display:

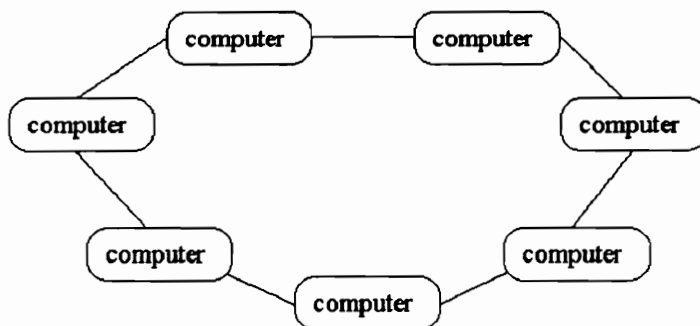
Star networks are called that because they look like stars. They have a CENTER or hub where all the computers in the network connect.



Ring network graphics

Display:

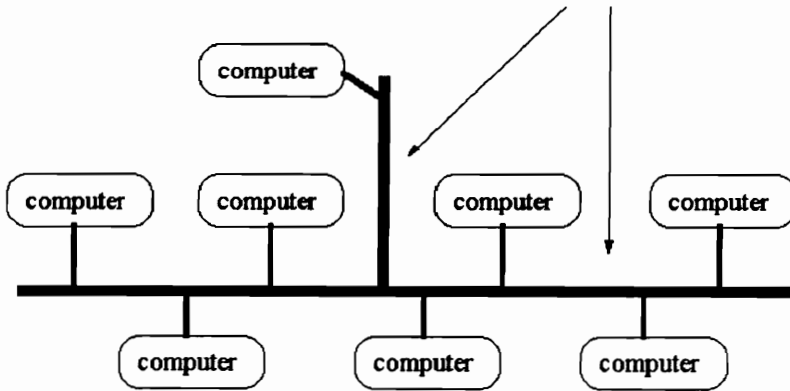
Ring networks are called that because they look like rings.  
All the computers in the network are connected together and  
pass an imaginary token with which they transfer data.



Bus network graphics

Display:

BUS networks are networks where all the computers are connected to a central line called a BACKBONE.



 Cable types

Display:

### Communications Channels:

The communications channel, also known as the Medium, is the actual wiring (or channel) that connects all of the devices in the network. The four main types of communications channels/mediums are: Twisted pair, Coaxial cable, Fiber Optic cable, and Wireless.



text/description

Display:

### *Twisted-pair cable*

Twisted -pair cable is not a solid cable. It is a series of small copper wires twisted together in an insulated shield. Common phone cable connections to **YOUR HOME** are made with twisted-pair cable. Many ethernet style networks are also connected with twisted-pair cable called 10BaseT cabling.

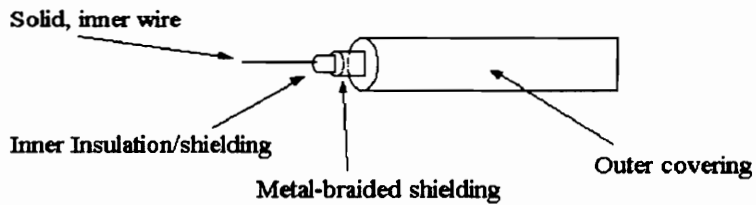


text/description

Display:

### *Coaxial cable*

Coaxial cable, also called COAX, is a solid cable. Coax is commonly used to connect homes with cable television (the round black cable that connects to your television). This cable is made of a solid internal wire surrounded by metal braided and fiber shielding all of which is enclosed in a plastic insulation.

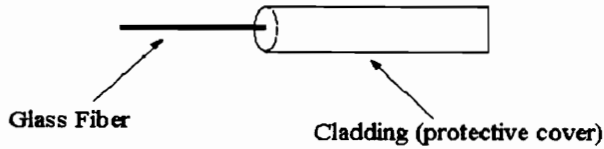


text/description

Display:

### *Fiber Optic cable*

Fiber optic cable is a communications channel consisting of strands of glass encased in a cladding (protective cover). Computer electronic signals are changed to light beams that travel down the strands of glass at very high speeds. This communications channel is the **FASTEST** and allows for the greatest amount of data to be transferred across one wire.



remember FIBER optics=FASTEST transmission!!

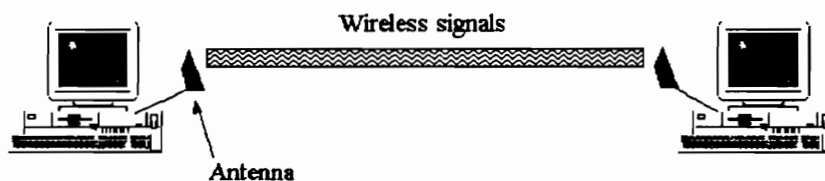


text/description

Display:

### *Wireless Communications Channels*

With the recent increase in cellular phone technology, Wireless communications are seeing more use. Computers are now being connected **WITHOUT** wires. With radio and infrared waves computers can talk without a physical cable connecting them. They only need to have a special antenna and software instead of cables to connect them and allow them to transfer information.



remember: Wireless = without cabling!!



Justification info

Display:

The following are key reasons  
(justification) for the use of Local Area  
Networks

1. Share files
2. Transfer files
3. Access information and files
4. Share applications
5. Simultaneously key data into an application
6. Printer Sharing
7. Electronic mail
8. Share hardware resources



Done

Display:

YOU ARE  
DONE

Please raise your hand  
and the teacher will pick up  
your paper.

Thank you

**APPENDIX C**  
**TUTORIAL POSTTEST**

POSTTEST - NETWORKING

Please complete the following questions to the best of your ability. Circle the correct answer.

1. The LAN topology which connects the workstations to a central line or backbone is called
  - A. Ring
  - B. Star
  - C. Bus
  - D. Hybrid
  
2. The LAN topology which most often uses token passing technology is
  - A. Bus
  - B. Ring
  - C. Star
  - D. Hybrid
  
3. The LAN topology which connects all nodes to a central computer is
  - A. Ring
  - B. Star
  - C. Bus
  - D. Hybrid
  
4. A central computer in a LAN which serves one primary function, to serve all workstations in a LAN, is
  - A. CPU
  - B. WAN
  - C. LAN
  - D. Server
  
5. The access protocol scheme, developed by Xerox, that is the most popular protocol used with LANs is called
  - A. Ethernet
  - B. Token-Passing
  - C. XZ500
  - D. VT100
  
6. The interconnection of two or more computers or computer peripherals is called
  - A. Network
  - B. Link
  - C. Node
  - D. Interconnection

7. All of the following are justifications for using Local Area Networks except
  - A. Share files
  - B. Mainframe access
  - C. Simultaneously key data into an application
  - D. Printer sharing
  
8. A single computer that is connected to a network is commonly called all of the following except
  - A. Workstation
  - B. Node
  - C. Station
  - D. LAN
  
9. A communications channel that uses antennas and invisible waves, to allow computers to communicate together is called
  - A. Twisted-pair
  - B. Coaxial cable
  - C. Wireless
  - D. Fiber optic
  
10. A network topology that connects only two (2) computers together is called
  - A. Point-to-point
  - B. Single-point
  - C. Multi-point
  - D. Many-to-many point
  
11. A device that links two different LANs is called
  - A. Cable
  - B. Gateway
  - C. Antenna
  - D. Node
  
12. A device that links two LANs with similar topologies
  - A. Node
  - B. Antenna
  - C. Cable
  - D. Bridge
  
13. All of the following are typical LAN servers except
  - A. Printer
  - B. Communication
  - C. Graphics
  - D. File

14. The hardware that connects the computers in a network is called
  - A. Communication channel
  - B. Hardwire
  - C. Softwire
  - D. Software
  
15. The software that runs a computer is referred to as the
  - A. Network Development [ND]
  - B. Network Access [NA]
  - C. Network Connection [NC]
  - D. Network Operating System [NOS]
  
16. LAN stands for
  - A. Local Area Network
  - B. Local Access to Networks
  - C. Locally Available Network
  - D. Local Availability of Networking
  
17. WAN stands for
  - A. Wide Access to Networks
  - B. Wide Area Network
  - C. Widely Available Network
  - D. World-Wide Access to Networks
  
18. The communications medium which transfers data the fastest is
  - A. Fiber optic
  - B. Twisted-pair
  - C. Coaxial cable
  - D. Unshielded cable
  
19. Standard telephone wire to your home is
  - A. Fiber optic
  - B. Twisted-pair
  - C. Coaxial cable
  - D. Unshielded cable
  
20. The most commonly used LAN topology is
  - A. Star
  - B. Bus
  - C. Ring
  - D. Tree

**APPENDIX D:  
PERSONAL CHARACTERISTICS COLLECTION FORM**

**PERSONAL CHARACTERISTICS**

PLEASE CIRCLE ONLY ONE ITEM PER QUESTION.

1. Please circle one of the following items, AM if your class is in the morning or PM if your class is in the afternoon.

AM

PM

2. Please enter your school name below

\_\_\_\_\_

3. Please circle the following item that represents your GENDER.

MALE

FEMALE

4. Please circle one of the following items, YES if you have access to a computer outside of school, NO if you do not have access to a computer outside of school.

YES - I have access to a computer outside of school

NO - I do not have access to a computer outside of school

5. Please rate your experience with computers by circling the item below that best describes, on average, how often you have been using computers over the past year.

No computer experience

1-4 hours per week

5-9 hours per week

10-15 hours per week

More than 15 hours per week

**APPENDIX E:  
FORMATIVE EVALUATION SHEETS**

## **Formative Evaluation Sheet for Multimedia Tutorial Interface**

1- Was the interface user-friendly and easy to navigate? YES NO  
Other feedback? \_\_\_\_\_

---

2- Did you understand the information/definitions? YES NO  
Other feedback? \_\_\_\_\_

---

3- Did you need clearer definitions/information? YES NO  
Other feedback? \_\_\_\_\_

---

4- Did you need more graphics to understand the material? YES NO  
Other feedback? \_\_\_\_\_

---

5- Did you ever get LOST in the program? YES NO  
Other feedback? \_\_\_\_\_

---

6- Did you feel that the time required to finish the program was (circle one):  
a) Too long  
b) Too short  
c) Just right

**PLEASE USE THE BACK OF THIS PAPER TO PROVIDE ANY FEEDBACK REGARDING YOUR OPINION, FEELINGS, AND USEFULNESS OF THE INTERFACE. YOUR RESPONSES ARE ANONYMOUS, SO PLEASE BE HONEST AND STRAIGHTFORWARD IN YOUR FEEDBACK. ANY INFORMATION THAT YOU PROVIDE WILL BE GREATLY APPRECIATED.**

## ***Formative Evaluation Sheet for Paper Tutorial***

1- Did you understand the paper tutorial directions ? YES NO  
Other feedback? \_\_\_\_\_

---

2- Did you understand the information/definitions? YES NO  
Other feedback? \_\_\_\_\_

---

3- Did you need clearer definitions/information? YES NO  
Other feedback? \_\_\_\_\_

---

4- Did you need more graphics to understand the material? YES NO  
Other feedback? \_\_\_\_\_

---

5- Did the information keep your interest? YES NO  
Other feedback? \_\_\_\_\_

---

6- Did you feel that the time required to finish the lesson was (circle one):  
a) Too long  
b) Too short  
c) Just right

**PLEASE USE THE BACK OF THIS PAPER TO PROVIDE ANY FEEDBACK REGARDING YOUR OPINION, FEELINGS, AND USEFULNESS OF THE INTERFACE. YOUR RESPONSES ARE ANONYMOUS, SO PLEASE BE HONEST AND STRAIGHTFORWARD IN YOUR FEEDBACK. ANY INFORMATION THAT YOU PROVIDE WILL BE GREATLY APPRECIATED.**

## VITA

Herbert (Herb) Franklin Brown, III was born in Corpus Christi, Texas on August 25, 1969. Herb grew up in many places around the United States including New Jersey, Ohio, Northern Virginia, and Orange Park, Florida. He attended public schools in all locations. He received an A.S. degree in business administration and management in 1990 at Florida Community College of Jacksonville.

Herb continued his education by attending the University of South Florida in Tampa, Florida in 1990. After a short stay in Tampa, Herb transferred to Virginia Polytechnic Institute and State University (Virginia Tech) where he finished his B.S. degree in Education with a specialization in business education in August 1993.

After completing the B.S. degree, Herb enrolled at Virginia Tech in the Master's program in Education. He graduated with his M.S. in Education with a specialization in business and vocational education in May 1994.

Herb's education toward a Ph.D. in Vocational and Technical Education continued at Virginia Tech in May 1994. While attending Virginia Tech, he concentrated in business education and computer information systems. He completed the Doctor of Philosophy degree in December 1996.

Herb's work experience is varied. He was employed for seven years in retail hardware, where he held jobs ranging from sales clerk to store manager. For three years while at Virginia Tech, Herb worked as a graduate teaching assistant, teaching classes in business education, computers, and supervising student teachers. He also performed

computer consulting work for the Virginia Department of Education and local school divisions in Virginia.

Other accomplishments for Herb include authoring a beginner's guide to the internet, being awarded National "Mr. Future Business Teacher" by Phi Beta Lambda in 1993, and presented at numerous conferences. In addition, he is a member of Delta Pi Epsilon, National Business Education Association, Southern Business Education Association, Virginia Business Education Association, Phi Delta Kappa, Phi Kappa Phi, Kappa Delta Pi, Omicron Tau Theta, and an adviser for Phi Beta Lambda. Herb is currently employed by James Madison University in Harrisonburg, Virginia.

A handwritten signature in black ink, appearing to read "Herb F. Brown, III", written over a horizontal line.

Herbert Franklin Brown, III