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THE EFFECTS OF MICROCOMPUTER INSTRUCTION ON KNOWLEDGE IN COMPUTER PROGRAMMING AND ATTITUDES OF SCIENCE EDUCATION STUDENTS

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The Effects of Microcomputer Instruction on Knowledge in Computer Programming and Attitudes of Science Education Students

A Thesis in

Curriculum and Instruction

by

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ABSTRACT

The purpose of this study was to determine the relative effects of two types of microcomputer instruction on science education students' knowledge in computer programming and their attitudes toward microcomputers.

There were two modes of microcomputer instruction. On the first mode (T-1), subjects received a teacher-guided approach which included formal human instruction, practice with Apple II microcomputers and an instructional canned program and printed materials in computer programming.

The second mode (T-2) subjects were provided an independent learning approach involving learning and practice with Apple II microcomputers coupled with printed materials in computer programming, but without formal human instruction or an instructional canned program. In T-2 a teacher was on call when the student had difficulty in the use of the microcomputer. In each type of instruction, the subjects worked individually.

The research design in this study was an experimental design with posttest-only. Twenty-four volunteer science education students were randomly assigned to the treatment groups. The two treatment groups experienced an identical workshop about the basic operation of the Apple II microcomputer prior to the treatment. The treatment period for each group was three weeks in length with four sessions held each week and each session lasting a total of 95 minutes.

The Behrens-Fisher t'-test and the Fisher's Z-transformation were used and an $\alpha = .05$ was accepted. The results showed that there were no significant differences in the mean score of T-1 and T-2 on either knowledge of computer programming or attitudes at the completion of treatment.

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CHAPTER I

INTRODUCTION

Background of the Study

In the last two decades, computers have worked their way into almost every segment of human endeavor and there is evidence to show that the future impact will be an accelerated extension of the immediate past (McIsaac, 1979). Bork and Franklin (1979), in reporting about the role of personal computer systems in education, stated that personal computers are becoming more and more available in educational institutions, in the home market, as part of people's jobs and in public environments such as libraries. The first microcomputer on a chip was introduced in 1971 by the Intel Corporation (Smith, 1979). At the June 1979 Consumer Electronic Show in Chicago, several new microcomputers were introduced by Texas Instruments, Atari, APF Electronics, and Material Electronics. These new microcomputers were well received (Smith, 1979). In 1972, the Committee on Computer Education of the Conference Board of the Mathematical Sciences concluded that:

> It is therefore essential that our educational system be modified in such a way that every student become acquainted with the nature of computers and the current and potential roles which they play in our society. (Hansen et al., 1979)

As proof of increased interest, Thomas (1979) reported that microcomputers have been discovered by a growing group of school officials, only after relentless prodding from their students, from parents, and from the advertising campaigns of microcomputer manufacturers. The existence of these relatively inexpensive computers can no longer be ignored by even the most conservative educator. Teachers, principals, and in-service training coordinators seek materials to learn about microcomputer application.

At present, Radio Shack's TRS-80 color computer innovation can be used with the plug-in ROM paks, or one may write his own programs in BASIC language. Also, it is expandable, and it can be attached to any color TV quickly and easily (Interface Age, 1981).

Microcomputers are a distinct and different technology that is based on semiconductor chips, whereas standard or minicomputers have a fundamentally different architecture, but a great many computer programs can be run or converted to run on all types of computers (Sippl, 1981).

Dusseldorp and Spuck (1979) have stated that basically the microcomputer is structured the same as the largest computers. It is physically smaller, slower, has less memory, but still can be a very powerful tool. However, the capacity and speed of a moderately sized micro are greater than all but the most powerful computers of two decades ago, and the price is but a fraction of the earlier models.

The Significance of Technology

In 1972, the Carnegie Commission on Higher Education published a report entitled, "The Fourth Revolution," in which the role of technology in education is explored. The title of the report was derived from Eric Ashly's observation that four great revolutions have occurred in education. The first revolution occurred when the responsibility of teaching children went to someone other than their parents. The second came with the written word. A third revolution was experienced when printing made books available on a wide scale. And today, with current technological advancements, we are in the midst of a fourth revolution.

Dusseldorp and Spuck (1979) noted that most of us already own a microprocessor; while many have purchased microcomputers, most of the microprocessors owned are packaged as a part of some other device, such as an automobile, a television set, a toy, a microwave oven, an electronic game, or a home security system. These devices represent a marked deviation from earlier technology in that they are "smart" systems which monitor inputs and selected preprogrammed courses of action. In about five years, the phenomenon of personal computing has emerged; now it, together with the microprocessing capability which supports it, has reached into almost every home, school system, college and university in the country.

Although computers are not new to education, their use in an instructional setting is relatively recent. Fifteen years ago, when computers were first seriously considered as a method of classroom instruction, their use involved submitting punched cards to be run on a batch system. The turn-around time could be anywhere from one hour to several days. This procedure made the instructional use of a computer very difficult. The major reason that computers are now available in the classroom is the development of time-sharing systems (Shirey, 1976). Computer time-sharing systems with the capability of telecommunications networks or satellite communications allow the students to have almost instantaneous feedback, and to use a computer without regard to where the computer is located. In addition, the turn-around time is generally a few seconds.

As a result of these breakthroughs in microprocessor and microcomputer design, instructional applications are being explored with increasing frequency. Moursund (1974) has presented a topology of these applications: (1) computer-assisted instruction (CAI), that is, the use of the computer as the main delivery source of instruction; (2) computer-managed instruction (CMI), that is, the use of the computer to maintain records and score tests, (3) computer literacy, that is, the non-technical study of computers and their applications. The present study will be concerned with the use of computers to provide CAI, that is, the use of computers to assist or extend the instructional and learning process.

The use of microcomputers in education is thought to facilitate learning in a variety of ways: (1) by motivating learning, (2) by speeding computations, (3) by simplifying complex processes through simulations, (4) by facilitating experimentation on relationships among variables, and (5) by providing immediate feedback. Even though microcomputer hardware and software are inexpensive and the cost is decreasing, they still represent a substantial expense to a school district. Therefore, introduction of the computer into the curriculum must be justified by empirical evidence on the basis of its contribution to the learning process (Shirey, 1976).

The realm of instructional application of computers is comprised of two major parts: teaching about computers and teaching with computers (Dennis, 1979). Teaching about computers is referred to as computer literacy. Teaching with computers may be used to facilitate instruction or such activities as:

1. Computer Managed Instruction or Computer Assisted Instruction
2. Drill-and-practice
3. Simulation
4. Computer-Assisted Testing
5. Instructional games
6. Tutorial
7. Problem solving
8. Classroom management

Need for the Study

The purpose of this study was to explore the applications of computers in performing an instructional function in a college setting, and to compare the effectiveness of CAI and formal human instruction with non-CAI and minimum human instruction (independent learning). At present, CAI is being used to supplement and complement formal human instruction or traditional instruction such as partial CAI and partial human instruction. Computers are used for several instructional purposes such as CAI, CMI, presentation of curriculum content, administration and grading of tests, computer graphics, text editing and word processing, computer-experiment interfacing, spread sheet planning (ESS User's Guide, 1984) and simulation.

The lives of individuals in our society are being affected increasingly by computers and microcomputers. Therefore, it is important that students should have contact with computers during their formal education to develop an understanding of how computers work and of how they can be applied.

In the past, researchers found that the attitudes toward computers are negative because the students, the educators, and the users felt that computers were too sophisticated and complicated. Rohner and Simonson (1981, p. 9) stated that:

> Innovation in education is seldom totally and immediately accepted. Resistance to change is attributed to a variety of reasons, including fear of automation, fear of job security, need for independence, role overload, laziness, the dehumanizing effect of technology, lack of supporting resources, and traditions. . . . The computer is one form of educational innovation that has met with resistance in some areas, in other areas it has been accepted through the use of facilitators and models for change.

Since many curricula are being modified to reflect the applications of computers in education, the need for adopting the microcomputer as an intelligent tool in the tutee mode, tutor mode, or as CAI and CMI is appropriate. The results of this study will be useful in seeking answers to some questions that may be raised by curriculum specialists and teacher educators.

Statement of the Problem

The purpose of this study was to determine the relative effects of two types of microcomputer instruction on science education students' knowledge in computer programming and their attitudes toward microcomputers.

Two types of instruction were given: (1) a teacher-guided approach which included formal human instruction, practice with the microcomputer, use of an instructional canned program, and printed materials in computer programming (T-1); and (2) an independent learning approach involving practice with the microcomputer coupled with printed materials in computer programming, but without formal human instruction or an instructional canned program (T-2).

The researcher measured acquisition of the knowledge in computer programming, and the attitudes of subjects toward using microcomputers in science, education, and by oneself.

This study was designed to answer the following questions:

1. Are there differences on mean scores of knowledge in computer programming across the two types of instruction?

2. Are there differences on mean scores of microcomputer attitude scores in science across the two types of instruction?

3. Are there differences on mean scores of microcomputer attitude scores in education across the two types of instruction?

4. Are there differences on mean scores of microcomputer attitude scores for oneself across the two types of instruction?

Hypotheses

Hypothesis 1

There will be no difference between the mean scores on the MKT of E_1 subjects who followed T-1 and the mean scores on the MKT of E_2 subjects who followed T-2.

Hypothesis 2.1

There will be no difference between the mean ATS scores of E_1 subjects who followed T-1 and the mean ATS scores of E_2 subjects who followed T-2.

Hypothesis 2.2

There will be no difference between the mean ATE scores of E_1 subjects who followed T-1 and the mean ATE of E_2 subjects who followed T-2.

Hypothesis 2.3

There will be no difference between the mean ATO scores of E_1 subjects who followed T-1 and the mean ATO of E_2 subjects who followed T-2.

Definition of Terms

For the purpose of communication between researchers and readers, the following terms, abbreviations and computer terms were used to describe the instructional treatments and to refer to the dependent measures.

Attitude: A relatively enduring organization of beliefs around an object or situation predisposing one to respond in some preferential manner (Rokeach, 1969, p. 112).

Attitudes Toward Using Computers: A semantic differential scale, which uses the method involving a forced choice between pairs of bipolar terms as to the direction of their relationship, consists of the pairing of each of 10 pairs of bipolar terms as developed by Shirey (1976). This scale was used to measure the attitudes toward using microcomputers in three different situations: in science, education, and by oneself.

Attitudes Toward Using Microcomputers in Science (ATS): A semantic differential scale from Shirey's Attitude Toward Computer Scale.

Attitudes Toward Using Microcomputers in Education (ATE): A semantic differential scale from Shirey's Attitude Toward Computer Scale.

Attitudes Toward Using Microcomputers by Oneself (ATO): A semantic differential scale from Shirey's Attitude Toward Computer Scale.

Computer-Assisted Instruction (CAI): The use of computers as a teaching process including any one or more of the following: drill and practice, tutorial, simulation and games, problem solving and immediate feedback (Hausmann, 1979).

Computer Managed Instruction (CMI): The use of computers as an instructional management system involving: organizing curricula and student data, monitoring student progress, diagnosing, prescribing, evaluating learning outcomes and providing planning information for instructors (Hausmann, 1979).

Courseware: In computer-assisted instruction (CAI) the actual instruction--including both content and technique--installed in CAI system. Courseware is different from software in that the software is the actual program which directs the computer operation (Educational Technology, 1977, p. 296).

Formal Human Instruction (Traditional Instruction): Any conventional non-computer teaching/learning strategy including lecture, group activities and question/answer, learning centers, laboratory instruction, experimental-community-based education (Hausmann, 1979).

Input-Output Equipment (I/O Unit): A unit whose basic function is to communicate between the user and the computer system. The input function provides the means for the user to enter programs, command and data to the processor, and the output function provides the means for the processor to return the answer to the user (Walker, 1981).

Instructional Treatment-1 (T-1): A teacher-guided approach which involved formal human instruction, practice with the microcomputer, use of an instructional canned program, and printed materials for knowledge in computer programming.

Instructional Treatment-2 (T-2): An independent learning approach involving practice with the microcomputer coupled with printed materials for knowledge in computer programming, but without formal human instruction or an instructional canned program.

Main Storage (Main Memory): A memory unit which holds the data and instructions used by the processor (Madnick and Donovan, 1974).

Menu-Driven Displays: The instructions and simulated practice sessions as they appear on the video display screen, designed especially for the users.

Microcomputer Knowledge Test (MKT): A set of 30 completion questions concerning computer components and computer programming in BASIC language, constructed by the researcher.

Microcomputer Knowledge Test Score (MKS): The number of correct responses on the Microcomputer Knowledge Test.

Processor or Central Processing Unit (CPU): A part of a computer system which contains the main storage, arithmetic unit, and special register groups. It performs arithmetical operations, controls instruction processing, and provides timing signals (Walker, 1981).

Secondary Storage: A unit which also holds data and instructions ultimately used by the processor. Secondary storage costs less than main storage per data item stored, but material stored there must first be transferred to main storage before the processor can utilize it (Madnick and Donovan, 1974).

Time Sharing: A technique of organizing a computer so that several users can interact with it simultaneously. The term "time-sharing" also refers to the multi-user's system (Ralston and Reilly, Jr., 1983, p. 1521).

Limitations

The limiting factors in the study are as follows:

(1) This study was limited to science education students at a large state university.

(2) A small number of microcomputers and computer time were available; therefore, the study was limited by a low sample size.

Summary of Hypotheses

The summary of hypotheses are as follows:

H 1 $MKT(E_1) - MKT(E_2) = 0$

H 2.1 $ATS(E_1) - ATS(E_2) = 0$

H 2.2 $ATE(E_1) - ATE(E_2) = 0$

H 2.3 $ATO(E_1) - ATO(E_2) = 0$

Summary

The purpose of this study was to compare the two types of microcomputer instruction on knowledge in computer programming and attitudes toward microcomputers of science education students. All hypotheses were stated nondirectionally.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

A review of the literature provides an examination of the areas of study which deal with: (1) an overview of educational technology; (2) computer technology in education, classes of computer systems, and computer software; (3) the use of computers in teaching knowledge; (4) computers and attitudes; and (5) computer-assisted instruction and human instruction or traditional assisted non-computer instruction related to this study.

Overview of Educational Technology

Educational Technology (1977, p. 296) defines the term, "educational technology," as follows:

> Educational technology is a complex, integrated process involving people, procedures, ideas, devices, and organization for analyzing problems and devising, implementing, evaluating, and managing solutions to those problems, involving all aspects of human learning. In educational technology, the solutions to problems take the form of all of the learning resources that are designed, selected, and utilized to bring about learning. These resources are identified as messages, people, materials, devices, techniques, and settings.

Finn (1965, p. 192) stated that:

> The concept of educational technology is integrative, meaning that it provides a common ground for

> professionals of many different fields. It permits the rational development and integration of new devices, materials, and methods as they come along.

The technologies which offer the most educational promise are computers, television, broad-band communications, and combinations of these. The computer is unique among information technologies in that it permits intelligent interaction with the learner. All previous informational technologies, such as printed books, video recordings, and broadcast or recorded television, have been one-way paths for distributing facts and ideas. But computers can interact in two-way communication as man-intelligent machine interaction.

Computer Technology in Education

Computers are only one of the several electronic devices currently available that can make a potentially significant contribution to instructional technology. Computers are now familiar on college campuses as multipurpose tools of administrative planners and financial officers, librarians, scholars engaged in qualitative analyses, and some teachers (Kerr, 1975).

Rockart and Scott Morton (1975) concluded, as did the Carnegie Commission in its own report on instructional technology, The Fourth Revolution (1972), that computers and other electronic media do have a useful and valuable role to play in instruction, but that it is likely to be one of enrichment rather than substitution for instructional use offered in conventional or traditional ways. They also concluded that instructional uses of the computer will be resisted in some part of the academic world, and may be held back in their development by current financial stringencies felt by colleges throughout the country.

A report of the Carnegie Commission on Higher Education (1972, p. 1) entitled The Fourth Revolution: Instructional Technology in Higher Education concluded that:

1. Higher education (and education generally) now faces the first great technological revolution in five centuries in the potential impact of the new electronics.

2. New technology has already transformed (a) research techniques in many fields and (b) administrative methods on many campuses. It is now (c) affecting large libraries and (d) is entering into the instructional process. . . . The new technology may provide the single greatest opportunity for academic change on and off campus.

3. The experience thus far with the new technology (applied to instruction), however, as compared with the hopes of its early supporters, indicates that it is (a) coming along more slowly, (b) costing more money, and (c) adding to rather than replacing older approaches--as the teacher once added to what the family could offer, as writing then added to oral instruction, as the book later added to the handwritten manuscript.

4. Nevertheless, by the year 2000 it now appears that a significant proportion of instruction in higher education on campus may be carried on through informational technology.

Based upon this conclusion, computer technology is available to assist the process of higher education.

The vital role played by computer technology in our contemporary society is receiving ever-increasing attention. As we increase the use of technology in education, the question of the effectiveness of computer technology-based instruction systems persists. And the content of this issue continues to reflect the impact that the computer, and in particularly the microcomputer, is having on the educational scene (Lio, 1983).

Classes of Computer Systems

The hardware components in a conventional system consist of four major components: the processor, main storage, secondary storage, and input/output unit.

Computers are classified by physical size and computational power or performance. At present, Elxi Systems uses multiple Motorola 68000 processors and it uses a wide system bus to achieve performance ratings claimed to approach 20 million instructions per second (MIPS) (Killmon, 1983). The general classifications currently used are, in order of decreasing size: large-scale general purpose computer, midicomputer, minicomputer, and microcomputer (Walker, 1981).

There are three basic ways that combinations of hardware and software can be put together for use by students and faculty. These approaches can be termed batch systems, remote job entry systems, and on-line interactive systems. Any of the three approaches can be utilized on an "in-house" basis, or on an "out-of-house" basis where the school rents time and service from an outside supplier (Bailey, 1978).

In the batch system, the user first converts his data and/or programs into machine-readable form, usually cards. He then physically transports this input to the computer room, where it is entered into the computer system and the program is run. Output data are produced at the computer.

The RJE system is the same as the batch system, with one exception. The converted data and/or program, in machine-readable form will be entered into a remote input device. The output may be received at the RJE terminal site through a printer, or it may be printed out at the main computer site.

In the on-line interactive system, the user communicates directly in a two-way path with the main computer, with different turn-around time according to computer speed and the priority or the category of the user.

In the case of microcomputer usage, it can be a microcomputer network system, a stand-alone unit or connected to the larger-scale computers through telephone lines and telecommunications networks or satellite communications by using additional devices, modems (modulator/demodulator) or acoustic couplers, which enable data to be transmitted over a long distance without error between the terminals (microcomputer) and the mainframe (computer time-sharing system) as a conversational mode (full duplex) (Narthasilpa, 1973). In order to turn the microcomputer into a terminal, it requires a hardware interface EIA RS232 and terminal software.

Computer Software

In addition to hardware, computers need and are heavily dependent upon the software they use. The software refers to the programs that run in a computer. Generally, software can be classified in four categories: operating systems, utility programs, language processors, and application programs, such as canned programs. In recent years, operating systems have become more and more important as a means of relieving programmers of some of the work of directing the computer.

Madnick and Donovan (1974, p. 11) have described the functions of operating systems as follows:

> The term, operating systems, denotes those program modules within a computer system that govern the control of equipment resources such as processors, main memory, secondary memory and I/O devices. They act as an interface between the user's programs and the physical computer hardware.

As computer hardware has become more complex, so have the operating systems. In addition, the purpose of a computer operating system is to share the computer equipment among several users in such a way as to maximize the system's throughput (Ralston and Reilly, Jr., 1983). The operating system (OS) has different names depending upon the tradename of the computer company, such as OS/MVS, OS/VM/CMS(3), TRSDOS, CP/M DOS, MS DOS2.0.

The Use of Computers in Teaching Knowledge

The impact of technology on education has as its center the question of the impact of technology on learning, in which the learning process is the manner in which people obtain and assimilate knowledge (Rockart and Scott Morton, 1975). The understanding of the learning process allows us to design systems using the latest technology in a reasonably optimal fashion.

Five sets of critical variables with regard to formal human instruction or traditional non-computer instruction have emerged from the research (Rockart and Scott Morton, 1975). They are:

1. The characteristics of the material to be learned.
2. The characteristics of the teacher.

3. The characteristics of the learner.
4. The stages of the learning process.
5. The learning environment.

Of these five categories, the first two appear to be most significant for this study which dealt with the learning material, the printed material and canned program, and human instruction.

Some believe that computer technology, perhaps more than any other means at the present, holds promise that we can deal with the educational problems of today and tomorrow in a significant fashion (Holtzman, 1970). This view is not shared by others who believe that the computer has a depersonalizing and alienating effect.

The types of usage for computer applications in teaching knowledge as discussed later have been successful in actual classroom use. There is no set pattern for implementing these techniques. The specific applications are dependent on the type of course, the instructor's goals, and student acceptance. The types of educational usage are as follows.

Canned Programs

Program packages are generalized computer programs written and stored for use by persons not familiar with a programming language (Anderson and Cover, 1972; Service, 1972). For each program, there is documentation that instructs the users on how to use it. Program packages may be designed to run in batch or interactive modes, the latter mode being the most useful for student learning (Kemeny, 1972), such as MSUSTAT (Caffarella, 1982). Some are quite extensive and do almost any type of data analysis or statistical testing, while others are more specific and handle special applications such as CAI in programming, CAI in music, CAI in foreign language, or CAI in physics.

Computer Graphics

Interactive computer graphics help users or learners visualize data and communicate results. The microprocessor and software have solved some of the original problems by providing the capability for manipulating graphic images or colored graphics at high speeds (Anundson and Squire, 1983).

The interactive capability made possible inherently graphic applications--design graphics that represent actual physical data, as in computer-aided design (CAD), image processing, and mapping.

There usually is an optimum type of graphic display for many particular purposes such as the standard line graph, the bar graph, pie chart, and the point or scatter graph. The choice of format depends on several factors. These include the nature of the data, the medium of presentation, the purpose of the graph and the type of learners.

In a computer graphic device, the user not only needs the capability to communicate information to others but to perform interactive analysis of data to better understand the meaning of results.

Simulation

Computer programs may be used to simulate certain phenomena, physical experiments, biological animation, or computer-experiment interfacing. In the area of statistics, for example, programs have been used to conduct sampling experiments based on random samples drawn from normal populations with specific parameters (Appelbaum and Guthrie, 1970; Garett, 1970).

Problem Generation

It is often desirable to supply each student with separate sets of data for the purpose of analysis and interpretation. Using the computer, it is possible to generate data sets by drawing random samples from populations, a procedure that produces a unique exercise for each student and discourages plagiarism, while at the same time offering convenience for the instructor (Halley, 1972).

Computational Examination Generator

The above applications, simulation and problem generation, are designed for homework, drill, and practice. However, the same general techniques may be utilized for generating test items and evaluation of student performance. This use of computers offers as many of the advantages as the problem generation procedure discussed above, specifically to produce individualized exams, and to make the exam production more convenient for the instructor or the teacher. Koteskey (1972) developed these procedures as a means of grading students in terms of the amount of material they master.

Examination Generation

The computer may be used to generate exams used to test student comprehension of subject matter in a variety of disciplines. Programs are available that randomly sample within each content area to produce different but equivalent examinations for each student and separate answer keys for the instructor (Wagener, 1973; Koteskey, 1972).

Automatic Exam Grading

For multiple examinations produced by any method, the computer may be used to score and evaluate student performance (Towle et al., 1973).

Student Tracking

In large classes, it often becomes difficult to maintain a record-keeping system that enables the instructor or teacher to keep track of the progress of his students. The computer may be used as a dynamic gradebook and filing system that may be updated and corrected by the instructor. It is particularly useful in self-paced or self-instructional courses (Bruell, 1972). Such systems can produce graphs of class performance, computer scores, standardized test scores, and assignment of grades. The student data bank may be interrogated to find students who may be having difficulty with the course so that they may be offered extra help (Castellon, 1973). This application can be used in practically any course.

Computers and Attitudes

Computer technology has become an integral part of our daily living. Simple processes such as cashing a check or making a phone call for which one relied on the services of a bank teller or an operator now are routinely handled and controlled by a computer. According to Levien (1972, p. 1), "We are now experiencing the transition from an era in which the computer was an esoteric tool to one in which the computer will be an everyday necessity. . . . the growth of computers has exceeded the most optimistic estimate."

The impact of computerized applications has increased in every segment of the educational system. Many factors tend to determine whether computers will be utilized, and to what extent. One of the most significant forces that influences the future acceptance and use of any technology is the attitudes and behavior of the educators involved. Some other primary factors, external to the university or school, include the government at all levels, the foundations, and the public as a whole. The first two of these influenced the direction of education to some extent through regulatory actions, provision or withholding of funding. The public has a dual role. On the one hand, it affects the economic climate of education by the provision of more or fewer students. On the other, it affects the type of education provided through its attitude toward education (Rockart and Scott Morton, 1975).

There is also a set of internal factors which has a substantial effect on the future of computers and higher education. There are evident trends in student attitudes and behavior that may significantly affect the process.

In education, the services of the computer have not been quickly accepted (Eastwood, 1978; Finley, 1970; Roberts, 1978). Like some other forms of educational technology, computers have been met with resistance to being included in the instructional process (Anastasio, 1972; Cooper, 1978; Kritek, 1976). Resistance to innovation and change has been a continual problem throughout the history of formal education, through the three technological revolutions as mentioned earlier. According to the Carnegie Commission (1972), with current technological advancements, we are in the midst of a fourth revolution.

At each of these four major periods of change, there was considerable resistance and rejection by many parents and educators. There continues to be resistance to various components of the fourth revolution, including the computer and microcomputer. This resistance has been attributed to rejection through ignorance, fear of the unknown, lack of incentives, rejection through experience (Eichholz and Rogers, 1964). Several researchers found that teachers resist change for a number of reasons. Below are some suggestions for teacher resistance to innovation as summarized by Rohner and Simonson (1981):

1. Eastwood (1978) stated that teachers feel that new technology would have a dehumanizing effect on students and teachers. While the academic portion of the curriculum might be enhanced, the importance of the teacher as a role model, counselor, or friend might be neglected. Teachers resisted even the experimenting with innovation in the schools because they thought it might have a detrimental effect on students.
2. Even if teachers accepted an innovation, resources in the form of manpower and software were often found to be insufficient or totally lacking (Eastwood, 1978; Roberts, 1978).
3. The lack of rewards for innovation was a barrier to change (Cooper, 1978; Eastwood, 1978).

4. The fact that teachers need to assume new roles with each innovation has caused role overload. A person can only assume a finite number of roles as new roles were required, old roles were modified (Kritek, 1976; Roberts, 1978).
5. Eastwood (1978) and Finley (1970) suggested that teachers fear they will lose their jobs. This fear stemmed from the concern that a machine would be able to teach more efficiently and that teaching staffs would be cut.

In summary, there are a multitude of barriers to innovation in the classroom, educational, economic, institutional and legal, but they are ". . . no more critical than barriers due to the attitude and traditions that have grown up about education" (Eastwood, 1978, p. 20).

Attitudinal Features

Rokeach (1969) defines the term attitude as a relatively enduring organization of belief around an object or situation predisposing one to respond in some preferential manner. There are many technical definitions of attitudes, but most have features in common. By combining the common features, we find that an attitude is an implicit cue- and drive-producing response to socially salient characteristics and that it possesses evaluative properties (Encyclopedia of Educational Evaluation, 1975).

The Encyclopedia of Educational Evaluation (1975, p. 32) stated that:

> The word implicit indicates that an attitude is within the individual. It can not be seen, felt, touched, or observed in any direct fashion. It can be inferred from certain kinds of behavior but it must always remain an inference of the observer. The

> phrase cue- and drive-producing means that an attitude held by a person will tend to cause that person to notice or do things selectively. Finally, the definition indicates that an attitude is, in a sense, a personal evaluation. It contains either a positive element (liking, wanting to be near) or a negative element (disliking, wanting to escape).

Since attitudes have three components--affect, cognition, and behavior--the test maker can do something to provoke an attitudinal response.

Computer Attitudes

There are a number of techniques commonly used to assess attitudes. Almost all of these techniques can be grouped under the headings such as attitudes toward using computers in different situations, computer anxiety, and computer enjoyment. But if the measurements are carefully made, groups can be assessed with relative accuracy, and the reliability and validity of the instrument used will indicate the accuracy of measurement.

Shirey (1976) studied the effects of computer-augmented instruction on students' achievement and attitudes. The purpose of the investigation was to determine whether students using computer-augmented instruction performed differently from their counterparts who used a calculator during instruction on measures of performance and attitudes after a unit concerning interest on home mortgages.

In a critical analysis of Shirey's work, Ligouri (1979) reported that Shirey used a research design in which students in grades 10 through 12 were randomly assigned to computer (N = 22) and calculator (N = 30) groups. Students were given pretests on vocabulary, knowledge, and attitudes on their first day. Both groups were then given identical instruction on home mortgages during the next six days, as well as experiences in running canned computer programs.

Four scales were developed to measure the students' attitudes toward using the computer in business, government, science, and by oneself. A test was given to determine the ability of students in computation. Another test measured the understanding of each student on home mortgages. Finally, a measure to determine the attitudes of each student toward the unit of instruction was developed.

Data analysis was performed using the analysis of covariance, chi-square test, and t-tests. The findings are summarized by Ligouri (1979) as follows: The computer group scored significantly higher on the attitude toward oneself's use of the computer than did the calculator group, but there was not a significant difference between the two groups on all other attitudes toward the computer. Significantly more calculator students performed some experimentation beyond the minimum when compared with the computer group. In attitude toward the unit, no significant difference was found.

Rohner and Simonson (1981) studied the development of an index of computer anxiety. Based upon the three components of attitudes, affect, cognition, and behavior, they constructed the statements which were arranged according to which component they referred. The statements dealt with the cognitive component, affective component and behavior related. The instrument, consisting of 10 target statements and 20 distractor statements, was administered to 175 education students in the undergraduate media course at Iowa State University. The score from the 10 target items was correlated to sex, hemisphericity, and field dependence. An analysis of variance was calculated between the scores on the Computer Anxiety Index and the subject's college major. The Computer Anxiety Index reliability estimate was .86. The results indicated that no statistically significant relationships were found for any variable.

Anderson (1981) studied the affective and cognitive effects of microcomputer based science instruction. Anderson designed an experiment to investigate the impact of a brief computer-assisted instruction (CAI) experience on the attitudes, beliefs, and knowledge of different types of students. A 20- to 30-minute science lesson on water pollution was administered to approximately 350 students by Apple II microcomputers. Comparison of pretest with posttests and tests six months later reveal some important impacts of exposing students to CAI for science instruction. The statistical results of attitude scales suggest that CAI modules, APOLUT, have potential for many classroom situations.

Computer Assisted Instruction (CAI) and Formal Human Instruction

Computer-assisted instruction (CAI) refers to the use of computers as a teaching process including any one or more of the following: drill and practice, tutorial, simulation and games, problem solving and instantaneous feedback. CAI is only one part of computer assistance in the process of learning and teaching.

Based upon the research review (Edward et al., 1975), CAI has been utilized as (1) a supplement or complement to high formal human instruction and (2) a substitute for traditional instruction with low level human instruction.

The Development of the Operational Use of CAI

Prior to the 1960's, the use of the computer in an instructional setting was virtually nonexistent. By 1960, IBM had developed the first CAI author language, Course Writer I, with which educators could program their curriculum ideas more directly (McLagan and Sandbough, 1977). In January of 1963, the Institute for Mathematical Studies in the Social Sciences (IMSSS) at Stanford University began research and development in CAI that has resulted in some of today's most widely used applications. The first use of CAI in an elementary school was in the spring of 1965, when 41 fourth-grade children were given daily arithmetic drill and practice lessons in their classroom on a typewriter machine that was connected to the Institute's computer by telephone lines (Suppes, 1972).

Another highlight of the Institute's work in the middle and late 1960's was the development of university-level computer-based programs. In 1967, a first-year Russian program was piloted using Stanford students (Suppes and Macken, 1978).

The PLATO system at the University of Illinois, which today delivers interactive material using alphanumerics, graphics, and animation, was a widely used CAI project begun in connection with Control Data Corporation and the National Science Foundation in the 1960's (Lacey, 1977). The Florida State University Center for Research in CAI also conducted several studies on computer-managed instruction in a programmed instruction course (Hagerty, 1970) and a health education course (Lawler, 1971).

Early in 1972, the MITRE Corporation and C. Victor Bunderson and associates at Brigham Young University began the development and field testing of the Time-shared Interactive Computer-Controlled Information Television (TICCIT) system of CAI. The purpose of this CAI system was to use the microcomputer and television technology to deliver CAI lessons and educational programs in English and mathematics to community college students.

The PLATO system in 1977 was in its fifth generation of development and is being marketed by Control Data Corporation. A network of PLATO learning centers operates in 50 cities throughout the United States, and offers employee training courses and courses in consumer education. The Physics Computer Development Project at the University of California has developed a CAI course in physics that involves many difficult modes of computer usage (Bork and Marasco, 1977).

Basic skills encompass the fundamental tenets and related skills for any discipline regardless of the age or level of the learner. For example, in the field of medical science, chemistry, and language study, medical students need to be completely familiar with basic anatomy, chemistry major students with basic chemistry; and foreign language students with certain basic vocabulary and grammar. CAI is obviously supportive in providing individual programs. The nature of technology forces educators to systematize the design and development of CAI. The resultant programs are well conceived and have been designed to provide diagnosis, instruction, drill, and assessment (Morgan, 1978).

Utilizing the computer to deal with learners, the OPTACON that translates, the "Speech Plus" talking calculator, and a silent electronic Braille reader/writer are other communication aids. Under this application, computer technology is used to compensate for a specific condition (Watson, 1978).

Some Applications and the Effectiveness of CAI and Human Instruction

CAI is usually prepared following one or a combination of three modes: drill and practice, tutorial, and simulation. Drill and practice has proved to be the most widespread, because it is the easiest to prepare and can be used to free teachers from daily routine work (Magidson, 1978).

In 1977 the Human Resources Research Organization (HumRRO) published an Academic Computing Directory which identified over 350 American schools, colleges, and universities that had used CAI successfully; and this listing does not cover all successful programs in these and other types of institutions. The reasons given for the nominations demonstrate to some extent why CAI-related learning can be useful: (1) evidence of student achievement; (2) evidence of increased institutional productivity; (3) a variety of applications in many subjects and courses; (4) the teaching of computer literacy; (5) an outstanding computer science or data processing program; and (6) an impact on other people or institutions. One effectiveness measure that should be included is how CAI usage affects student attitudes toward their learning--its impact is highly positive (Magidson, 1978).

Published studies comparing the effectiveness of CAI to traditional instruction report conflicting results, but generally conclude that CAI is at least as effective and often more effective (Kulik and Jaksa, 1977). These studies also showed that CAI learning requires less time. It should be noted that many of these studies contrast only drill and practice or tutorial formats to traditional instruction. The simulation format may be the only economical way of presenting some instruction. Furthermore, in light of the "knowledge explosion," simulations may be much more effective than traditional learning, because they allow learners to deal with new situations and to apply various steps in decision-making and in open-ended problem-solving. Also, most CAI is currently being used to supplement and complement traditional instruction, not to replace it, which makes it extremely difficult to compare CAI and traditional instruction.

A new audiovisual medium combining CAI with videodisc technology was developed by Control Data Education Company and by WICAT, a recently established non-profit corporation (Magidson, 1978). The videodisc system can be used alone or in conjunction with a computer as an information processing system (Maroun, 1980).

CAI in Programming

At Stanford University, teaching of computer programming began with the development of a high-school CAI course in machine language programming (Lorton and Slimick, 1969). The project was called SIMPER, and lessons in the BASIC language were presented.

CAI in Chinese

Development of a program to teach spoken Mandarin was begun in 1975 by Peter E-Shi Wu, a Ph.D. candidate in the School of Education at Stanford University. During instruction, the computer "spoke" in Mandarin and students responded to multiple-choice exercises by pushing the appropriate digits on the telephone pad (Suppes, Smith, and Beard, 1977).

CAI in Music

Since 1972, several applications of a computer-controlled system have been developed for various theoretical and instructional topics in music (Higgins, 1983; Kuhn, 1975). Music instruction demands a highly individualized approach and the development of the CAI in music has focused on five specific requirements: need for sound, need for real time instruction, need for individualization, need for detailed student records, and need for basic research.

CAI in Drill-and-Practice

By 1970, almost all of the projects were in university research settings, especially universities with substantial computer resources. In the past few years, however, many school districts have begun to run their own CAI programs, drill-and-practice programs in elementary mathematics and reading.

Fletcher and Atkinson (1972) tested the efficiency of a reading program by using a group of 50 matched pairs of first-grade students. The scores of students significantly favored the CAI groups.

Byers (1973) compared three modes of computer-augmented instruction: (1) extensive, where students learned to program in a statistical language; (2) limited, where students used canned programs; and (3) none, where students were exposed to traditional teaching methods. Byers found that extensive use, the first mode, allowed students to do more application-type problems. Both the limited-use and the no-use groups did far fewer problems than the extensive-use group. The students stated that the computer was very useful in performing numerical computations, and that using the computer was much easier than they expected.

Lange (1973) reported that an experimental group which used a computer to do homework assignments in calculus was superior to a control group which used traditional paper-and-pencil methods on a test of calculus concepts.

Several studies have investigated use of the computer to provide problem sessions for students. Hansen, Dick, and Lippert (1968) reported results of using CAI to handle problem sessions in a college physics course. Three groups of students were compared: (1) students receiving the bulk of instruction by CAI, (2) students receiving partial CAI and partial human instruction, and (3) students receiving no CAI. Results showed that the all-CAI group did significantly better than the other groups on the achievement measures, but the differences between students who received partial CAI and students who received only human instruction were not significant.

Other Instructional Applications of CAI

Piel (1973) reported on a year-long study to determine the effect of using computer simulations to augment instruction. The materials evaluated were the Huntingdon II computer simulations, developed for use in high school and college. They cover many areas of instruction such as mathematics, science, business, and social studies. The simulations model real life situations. An example is a simulation which models some parts of the United States economy. The student is able to alter factors of the economy and see immediate and long-range effects.

Coombs and Peters (1971) used the PLATO system to study CAI in role-playing games. One hundred and six students in an introductory American government course spent 18 class hours at terminals. Comparisons were made with the same number of students who received formal human instruction during the 18 hours in small group discussions. There were no significant differences between the two groups on the achievement test given at the end of the course.

Minor (1981) studied research dealing with adult learning via computer-assisted instruction. A three-year study evaluated the cognitive and affective effects of computer-assisted instruction (CAI) on adult basic education students. During the first year, the system was used by learning laboratory students only, but it was also used by classroom students during the remaining two years, and the 100 students enrolled used CAI regularly as a core part of their study. The curriculum in the drill and practice program consisted of Adult Reading Skills, Adult Arithmetic Skills, and Adult Language Skills I and II. Based on mastery learning instruction ranged in level from the third through the seventh grades. The experimental-control group design used contained three elements: (1) comparison of growth on California Achievement Tests in reading and mathematics, (2) comparison of time spent in the program, and (3) examination of students' attitudes toward learning and the use of CAI. Staff and student reactions to CAI use were uniformly positive, and the results of third-year and three-year studies confirmed that CAI use had led to significant cognitive and affective growth.

Lowery and Knirk (1982) studied the microcomputer video games and spatial visualization acquisition. The children spend many hours of their free time "playing" computerized video games. One area of impact on a child seems to involve spatial visualization. This skill has been defined as the ability to imagine movements, transformations, and other changes in visual objectives. Spatial visualization can be thought of as the ability to perceive and mentally retain two- and three-dimensional objects and their relation to their environment. The results showed that the higher order skills of analyzing and evaluating are certainly involved in video game play, but the emphasis here has been chiefly on the acquisition of spatial visualization skills. There appears to be a correlation relationship between high spatial ability and mathematical ability.

Summary

This chapter dealt with an overview of educational technology, computer technology in education, classes of computer systems and computer software, the use of computers in teaching knowledge, computers and attitudes, and CAI and human instruction. Also, included was a research review concerning applications of CAI and its effectiveness as a supplement and a substitute in whole or in part to formal human instruction related to this study.

CHAPTER III

PROCEDURE AND DESIGN

Introduction

This chapter describes the subjects participating in this study, the Apple II microcomputer used by the participants, the experimental design used for this study, the independent variables specified by the researcher and the dependent variables selected to be studied. It also includes a description of the instruments used to measure the dependent variables, the instructional provision and procedures employed, research design and procedure, and the statistical procedures used to test the hypotheses.

Subjects

The research design in this study was an experimental design with posttest-only. Twenty-eight volunteers enrolled in a senior level science methods course at a large eastern university were randomly assigned to one of two instructional treatments (T-1 and T-2). The sample was twenty-four subjects present at the orientation microcomputer workshop and each of the four 95-minute sessions held Monday through Thursday evenings. The treatment period for each group was three weeks in length. Subjects who missed one or more sessions were not eligible for hypothesis testing.

The Microcomputer as a Tool

The Apple II that was used in this study was a general-purpose microcomputer system which is versatile and reliable. The components of the Apple II microcomputer consist of typewriter keyboard, central processing unit and built-in memory (48 kilo bytes), diskette drive unit, and a visual display unit or cathode ray tube. These components are the minimum required to operate the Apple II system.

There are three modes of using the microcomputer in education (Taylor, 1980). The framework suggested for understanding the application of computing in education depends upon seeing all computer use in such applications as in one of three modes. In the first mode, the microcomputer functions as a tutor. In the second mode, the microcomputer functions as a tool. In the third mode, the microcomputer functions as a tutee or student.

In this study, the microcomputer was used as a tool. Because of their everyday familiarity with computing capabilities, most people in education use the computer as a tool.

Experimental Design

When discussing three basic experimental designs, Campbell and Stanley (1966) argued that the Posttest-Only Control Group Design should be preferred for the following reasons, all pertinent to this study:

1. The most adequate all-purpose assurance of lack of initial biases between groups is randomization.

2. Within the limits of confidence stated by the tests of significance, randomization can suffice without the pretest.
3. If one is concerned about the pretest interaction, this design would be employed because of the large number of groups otherwise required.
4. This design controls history, maturation, testing, instrumentation, regression, selection, mortality, interaction of selection and maturation, etc. as possible sources of internal invalidity.
5. This design controls "interactions of testing and treatment" as a source of external invalidity, whereas the Pretest-Posttest Control Group Design does not.
6. This design offers a greater control of "reactive arrangements" as a source of external invalidity.

The design used in this study can be represented by the following schematic diagram:

$$R_1 \rightarrow X_1 0_1 0_2 0_3 0_4$$

$$R_2 \rightarrow X_2 0_1 0_2 0_3 0_4$$

Legend:

R_1: The number of subjects randomly assigned to treatment group E_1.

R_2: The number of subjects randomly assigned to treatment group E_2.

0_1: The microcomputer knowledge test (MKT).

0_2: Attitude toward using the microcomputer in science (ATS).

O_2: Attitude toward using the microcomputer in education (ATE).

O_4: Attitude toward using the microcomputer oneself (ATO).

X_1: E_1 treatment (T-1).

X_2: E_2 treatment (T-2).

In this experiment, a table of random numbers was used to assign 28 college-level science education students to the two treatment groups. These subjects were eligible for hypothesis testing if they were present at the two-hour orientation workshop and missed no more than one of the 11 treatment sessions. Table I shows the number of subjects that were initially randomly assigned to each of the two treatment groups and the number of subjects eligible for testing the hypotheses.

Table I

Summary of Assignment to Experimental Treatment Groups

Experimental Treatment Group	Number of Subjects Assigned	Number of Subjects Eligible for Hypothesis Testing
T-1	14	12
T-2	14	12
Total	28	24

Independent Variables

There was one independent variable in this study: type of instruction. Two types of instruction were given: E_1 subjects received a teacher-guided approach which included formal human instruction and practice with the microcomputer, use of an instructional canned program, and printed materials on computer programming (T-1). E_2 subjects received an independent learning approach involving practice with the microcomputer coupled with printed materials on computer programming without formal human instruction or an instructional canned program (T-2), as shown in Appendix C. In T-2 a teacher was on call when the subject had difficulty with the use of the microcomputer. In each group, the subjects worked individually. The contrast of instruction for the two treatment groups is presented in Figures I and II.

Dependent Variables

There were four dependent variables in the study. These include:

1. Attitudes toward using the computer in science (ATS):
2. Attitudes toward using the computer in education (ATE):
3. Attitudes toward using the computer by oneself (ATO):
4. The Microcomputer Knowledge Test Score (MKS) in computer programming.

The instruments, which were administered to each treatment group at the end of the treatment session, are included in Appendices A and B. The summary statistics of the data are presented in Table V.

Instruments

Attitude Toward Microcomputers

The semantic differential scales were developed by Shirey (1976), modified by the researcher and used to test the attitudes of the subjects following treatment. The scale consisted of three parts, each with 10 pairs of bipolar adjectives. The parts were the attitudes toward the use of microcomputers: (1) in science, (2) in education, and (3) of oneself.

Reliability data on the attitude scale in different situations are shown in Table V. The internal consistency of the measure on Cronbach's coefficient alpha was 0.96 and 0.94 for T_1 and T_2, respectively. On the total scale and the average inter-item Pearson correlation coefficient was 0.47 and 0.34 for T_1 and T_2. The data suggest that Shirey's attitude scale modified was reliable for use with this sample. The alpha from Shirey's attitude subscales, from original studies, ranges from 0.89 to 0.92 when used as posttests.

Table VI shows the correlation values from the total scale and the three components. The correlation coefficients range from 0.75 to 0.97. The correlation between subscales from Shirey's original scale ranges from 0.25 to 0.61 when used as posttests. The subscale total correlation suggests that the scales have a common factor, suggesting that the scale is unidimensional.

A copy of the attitude scale is shown in Appendix A.

Microcomputer Knowledge Test

The Microcomputer Knowledge Test was a set of 30 completion questions (total possible points = 76) designed by the researcher to test the acquisition of knowledge about computer components and computer programming in BASIC language. In an effort to establish content validity, each test item was carefully drawn from the content covered by each subject in both treatments, as shown in Appendix B. The internal consistency of the measure on Cronbach's coefficient alpha was 0.91 and 0.83 for T_1 and T_2, respectively, as shown in Table V. These values suggest that the instrument was reliable. The average inter-item correlations, shown in Table V, are less reassuring. The results of an internal consistency analysis obtained by computing Cronbach's alpha and the average inter-item correlation are shown in Table V.

A copy of the Microcomputer Knowledge Test is included in Appendix B.

Instructional Procedure for Treatment

The researcher chose the printed materials dealing with the concept of computer components and the use of the Apple II microcomputer to learn about computer programming and some application programs in BASIC language designed for the beginning users, as shown in Figure II: (a) the New Step by Step - An Interactive Course in BASIC Programming for Beginners (Simon, 1981); (b) I speak BASIC to My Apple (Jones, 1982); (c) instructional canned program on the floppy diskette, same title as (a) (Simon, 1981).

Students were assigned to two treatment groups using a random numbers table. The amount of time spent on the treatment was the same for each group. The delivery of instruction was done according to the contrast of instruction between T_1 and T_2, shown in Figure II, and the instruction plan, as shown in Appendix C.

The subjects in the two treatment groups T_1 and T_2 attended an identical two-hour orientation workshop directed by an instructor about how to use or operate the Apple II microcomputer as shown in Figure II. The subjects also learned how to use canned programs. Each subject had an opportunity to have "hands-on" experience with the microcomputer and interact with it using an introductory program. They were given enough time to familiarize themselves with materials and procedure for using the microcomputer. Thus, each subject in the two groups received the same background information. The purpose of the orientation workshop was to provide the standard introduction.

In the experimental phase, subjects in each group followed the instructional plan of an instruction unit and worked individually. The treatment period for each group was three weeks in length, with four sessions held each week and each session lasting a total of 95 minutes.

Figures I and II provide a schematic diagram and a summary contrasting the instructional provisions for the two treatment groups. Instructors who participated in this study were knowledgeable about the Apple II microcomputer and BASIC language (Applesoft).

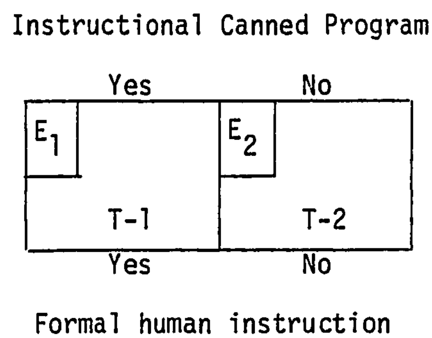

Figure I

A Schematic Diagram of Two Treatments
(posttest only) Using the
Apple II Microcomputer

Research Design and Procedure

In this study, the research design utilized was posttest only. In Roberts' review of studies (1980) about the impact of electronic calculator on the educational performance, the basic research design utilized was pretest-posttest. The advantage and disadvantage of the research design when compared to this study are summarized and presented in Table II. The purpose of Table II was to compare six studies related to this study. A brief explanation is given here as to the descriptors used in this table. The studies are listed from elementary school and secondary school through college.

Instructional Provisions	T_1	T_2
1. A microcomputer for each subject	Yes	Yes
2. Two-hour orientation workshop to acquaint subjects with basic operation of hardware	Yes	Yes
3. Reading Materials: a) The New Step by Step - An Interactive Course in BASIC Programming for Beginners (Simon, 1981)	Yes	Yes
b) I Speak BASIC to My Apple (Jones, 1982)	Yes	Yes
4. Periodic quizzes (self-testing)	Yes	Yes
5. Formal human instruction (beyond orientation)	Half Treatment Period	None
6. Practice time on computer	Half Treatment Period	Nearly All the Treatment Period
7. Instructional canned program on the floppy diskette, same title as 3(a) (Simon, 1981)	Yes	No
8. Teacher feedback	On Call During Practice	On Call During Practice

Figure II

Contrast of Instruction for
Two Treatment Groups

Table II

Summary of Pertinent Data for Micro/Computer and Calculator Studies

Study (1)	Cont. (2)		Design. (3)		Treat. Length (4)	Retent. Test (5)		Micro. or Cal-culator Use (6)		Stud. Assign. (7)			Results (8)			Analy. (9)				Intern. Valid. (10)			
	M	O	PP	O		Y	N	Y	N	S	C	?	Cm	Cn	A	t	An	Ac	O	S	I	C	T
						Elementary-Level Research																	
Hohlfeld (1974)	✓		✓		1 month	✓		?	?			✓	✓					✓		-	+	-	+
Nelson (1976)	✓		✓		4 weeks		✓		✓		✓		✓		✓			✓		-	+	-	+
						Secondary-Level Research																	
Zepp (1976)	✓		✓		2-3 weeks		✓	✓		✓							✓			+	+	-	-
Shirey (1976)		✓	✓		4 weeks	✓		✓ computor/ cal.			✓		✓		✓	✓				+	?	?	?
						College-Level Research																	
Ayers (1977)	✓			✓	1 term		✓	?	?		✓		✓	✓			✓			-	+	-	?
Roberts & Fabrey (1978)		✓		✓	1 hour		✓	✓		✓			✓		✓	✓	✓			+	+	+	+
Narthasilpa (1983)		✓		✓	3 weeks		✓	Micro-computer		✓			✓	✓	✓	✓ (t')				+	+	-	-

Legend: t' = Behrens-Fisher t-test; - = Internal validity; + = No internal validity; ? = It is not clear.

Explanation to Table II

(1) Researcher.

(2) Content refers to either traditional mathematics (M) settings or others (O) (science, statistics, chemistry, computer programming, etc.).

(3) The design listing includes the pretest-posttest (PP) arrangement (most popular) and other (O) arrangements (posttest only, etc.).

(4) Treatment length is self-explanatory.

(5) The retention test columns refer to whether a second (or third) posttesting occurred (Yes, Y, or No, N) after the treatment was completed.

(6) The time between the first micro/cal. and posttest and retention testing varied considerably. Micro/cal. use describes whether students in the E group were allowed to use micro/cal. (Yes, Y, or No, N) on the posttests. In cases where there are check marks for both Y and N, either the same students took two tests, one using micro/cal. and another not using micro/cal., or different groups of students completed one test under each condition.

(7) The student assignment classification: S means professed (by investigator) random assignment of students; C means by classroom; O means other.

(8) Results are classified into computational (Cm), conceptual (Cn), and Attitudinal (A) benefits.

(9) The analysis breakdown concerns whether the investigator used simple t-tests, analysis of variance (An), analysis of covariance (Ac), or other procedures (regression, etc.).

(10) The internal validity columns refer to four factors considered: S for assignment of students to conditions (this received a minus (-) if it were not random), I represented the instrumentation used (primarily tests), C symbolized whether contamination between the E and C groups could have occurred easily, and T refers to control of the teacher variable. The I decision was basically one of whether the tests used could have been (on initial examination) sensitive to possible E and C differences. For the C decision, if E and C students were in the same school, especially if taught by the same teacher, it was given a minus (-) because the E and C students could converse about the experiment. The T decision had to do with whether the teacher variable was reasonably controlled. If multiple teachers were assigned (essentially at random) to the different E and C conditions then it was rated as a plus (+) but if only one teacher taught both E and C, or if one teacher taught E and another taught C, then it received a minus (-) rating.

Statistical Procedures

The Behrens-Fisher t'-test was used to test the statistical hypotheses for the significant difference between the mean scores on the microcomputer knowledge and attitude toward computer. Justification for the use of the Behrens-Fisher t'-test was based on the research of Games and Howell (1976) and Scheffé (1970). If it is not known whether the two populations have the same variance, the *t*-test is not robust. Instead, an approximation to *t*, the t'-test, may be computed. In addition, according to Games (1972), the virtue of the Behrens-Fisher t'-test over the *t*-test is as follows: for small samples, t'-statistics should be used to secure adequate control of type I error, even when the sample sizes are equal.

The Fisher's z-transformation of the correlation coefficient (Glass and Stanley, 1970) were utilized to test for significant differences on correlation between scales of attitudes toward microcomputer, and the correlation between the microcomputer knowledge scale and attitude scales. All statistical hypotheses are stated nondirectionally and the .05 level of significance has been accepted for the study.

Summary

This chapter dealt with the procedures used in the experiment. The Posttest-only Control Group Design was used in this study. The Apple II microcomputer was used as a tool. Shirey's Attitudes Toward Using Computers, which was modified, was used in three different situations: in science (ATS); in education (ATE); and of oneself (ATO).

The Microcomputer Knowledge Test (MKT), composed by the researcher, was used to measure the acquisition of knowledge in computer programming. In the analysis of data, the Behrens-Fisher t'-test and the Fisher's z-transformation were employed. All statistical hypotheses were stated nondirectionally and tested at the .05 (α) level of significance.

CHAPTER IV

RESULTS OF THE INVESTIGATION

Introduction

This chapter contains a summary of the data collected to test the hypotheses of this study, the procedures used in the evaluation of each hypothesis, the results of the statistical tests of each hypothesis, and a summary of the results. The hypotheses and results in the final summary are stated in algebraic notation.

A Behrens-Fisher t'-test was computed using the SPSS statistical package of the Computation Center at The Pennsylvania State University. The RELIB, LIKERT, and SPSS statistical packages of the Computation Center at The Pennsylvania State University were used to analyze Cronbach's coefficient alpha of microcomputer knowledge, microcomputer attitude scale, and the correlation among the four dependent variables.

Hypothesis Testing

The following procedures were used in the evaluation of each of the two hypotheses and subhypotheses:

1. The research hypothesis is stated.

2. The mean and standard deviation of each of the two treatment groups relevant to the hypothesis are stated.

3. The statistical hypothesis (H_0) is stated.

4. A decision is stated based on the following rule:

   If $|t'| \geq t_\alpha$ with df at the $\alpha = .05$, reject H_0.

   If not, retain H_0.

5. An interpretation of the results of the test is given.

Hypothesis 1

1. There will be no difference between the mean score on the MKT of E_1 subjects who followed T-1 and the mean score on the MKT of E_2 subjects who followed T-2.

2. As shown in Table III, the mean and standard deviation of the two groups are as follows:

Mean T-1 = 48.92	Standard Deviation = 13.75
Mean T-2 = 50.67	Standard Deviation = 10.42

3. H_0: There is no difference between the means of treatment groups T-1 and T-2.

4. By using the t' test, there are no significant differences between mean scores of T_1 and T_2 on the microcomputer knowledge in computer programming at the .05 level of significance, t' = -.35, df = 21.

5. Interpretation: The differences between the mean scores were not significant.

Hypothesis 2.1

1. There will be no difference between the mean ATS score of E_1 subjects who followed T_1 and the mean ATS scores of E_2 subjects who followed T_2.

Table III

Cell Summary for Microcomputer Knowledge and Microcomputer Attitude

Variable	Experimental Treatment Group	Number of Subjects	Mean Score	Standard Deviation	Minimum Score Obtained By Subject	Maximum Score Obtained By Subject	Behrens-Fisher Values t'	df	Prob.
Knowledge	T-1	12	48.92	13.75	15	71	-.35	21	.73 (N.S.)
	T-2	12	50.67	10.42	30	64			
Attitude									
Science	T-1	12	56.33	7.68	45	66	.03	22	.98 (N.S.)
	T-2	12	56.25	7.32	39	66			
Education	T-1	12	57.08	10.09	40	69	-.12	19	.91 (N.S.)
	T-2	12	57.50	6.84	43	65			
Oneself	T-1	12	56.92	10.78	30	70	-.17	20	.86 (N.S.)
	T-2	12	57.58	7.87	43	69			
Attitude Total)	T-1	12	170.33	27.03	115	203	-.11	20	.92 (N.S.)
	T-2	12	171.33	18.84	125	194			

Behrens-Fisher t' at $\alpha = .05$

2. As shown in Table III, the mean and standard deviation of the two groups are as follows:

Mean T-1 = 56.33 Standard Deviation = 7.68

Mean T-2 = 56.25 Standard Deviation = 7.33

3. H_0: There is no difference between the means of treatment groups T-1 and T-2.

4. By using the t'-test, there are no significant differences between mean scores of T_1 and T_2 on the microcomputer attitude in science at the .05 level of significance, t' = .03, df = 22.

5. Interpretation: The differences between the mean scores were not significant.

Hypothesis 2.2

1. There will be no difference between the mean ATE score of E_1 subjects who followed T-1 and the mean ATE scores of E_2 subjects who followed T-2.

2. As shown in Table III, the mean and standard deviation of the two groups are as follows:

Mean T-1 = 57.08 Standard Deviation = 10.09

Mean T-2 = 57.50 Standard Deviation = 6.84

3. H_0: There is no difference between the means of treatment groups T-1 and T-2.

4. By using the t'-test, there are no significant differences between the mean scores of T_1 and T_2 on the microcomputer attitude in education at the .05 level of significance, t' = -.12, df = 21.

5. Interpretation: The differences between the mean scores were not significant.

Hypothesis 2.3

1. There will be no difference between the mean ATO scores of E_1 subjects who followed T-1 and the mean ATO scores of E_2 subjects who followed T-2.

2. As shown in Table III, the mean and standard deviation of the two groups are as follows:

Mean T-1 = 56.92 Standard Deviation = 10.78

Mean T-2 = 57.58 Standard Deviation = 7.87

3. H_0: There is no difference between the means of treatment groups T-1 and T-2.

4. By using the t'-test, there are no significant differences between the mean scores of T_1 and T_2 on the microcomputer attitude by oneself at the .05 level of significance, t' = -.17, df = 20.

5. Interpretation: The differences between the mean scores were not significant.

Summary of Hypothesis Testing

A summary of the results of the tests of each hypothesis is presented in Table IV.

The Internal Consistency of the Measures

Reliability data on the attitude scale in different situations and the microcomputer knowledge test are shown in Table V. The internal consistency of the measure on Cronbach's coefficient alpha was 0.96 and 0.94 for T_1 and T_2, respectively, on the total scale and the average inter-item Pearson correlation coefficient was 0.47 and 0.34 for T_1 and T_2, respectively.

Table IV

A Summary of Hypotheses Testing

Hypothesis		Result	Interpretation
H 1	$MKT(E_1) - MKT(E_2) = 0$	$MKT(E_1) = MKT(E_2)$	T-1 did not produce a significantly different mean MKT than T-2
H 2.1	$ATS(E_1) - ATS(E_2) = 0$	$ATS(E_1) = ATS(E_2)$	T-1 did not produce a significantly different mean ATS than T-2
H 2.2	$ATE(E_1) - ATE(E_2) = 0$	$ATE(E_1) = ATE(E_2)$	T-1 did not produce a significantly different mean ATE than T-2
H 2.3	$ATO(E_1) - ATO(E_2) = 0$	$ATO(E_1) = ATO(E_2)$	T-1 did not produce a significantly different mean ATO than T-2

Note: T-1 = A teacher-guided approach with an instructional canned program.

T-2 = An independent learning approach without an instructional canned program or formal human instruction.

Table V

Internal Consistency of the Measure

Test (posttest only)	Cronbach's Alpha* T_1	Cronbach's Alpha* T_2	Average Inter-item Correlation T_1	Average Inter-item Correlation T_2
Attitudes toward microcomputers				
1) Science	0.79	0.86	0.28	0.38
2) Education	0.93	0.89	0.53	0.44
3) Use by oneself	0.94	0.92	0.60	0.53
Total	0.96	0.94	0.47	0.34
Microcomputer Knowledge	0.91	0.83	0.18	0.10

*N = number of subjects for each alpha coefficient and average inter-item correlation

N_1 = 12 for T-1

N_2 = 12 for T-2

Correlation Among the Four Dependent Variables

To determine if significant correlations existed among the four dependent variables of this study, the SPSS statistical package of the Computation Center at The Pennsylvania State University was employed. The Pearson Product-Moment correlation coefficients were computed and compared with a table of "critical values of the correlation coefficient" (Glass and Stanley, 1970, p. 534).

Correlation between Scales of Microcomputer Attitude in Science, Education, and by Oneself

By using Fisher's Z-transformation of the correlation r, the two group correlation coefficients, r_1 and r_2 for T-1 and T-2, are calculated respectively and then transformed to Z_{r_1} and Z_{r_2} by means of Table G (Glass and Stanley, 1970, pp. 311-313, p. 534), the critical value of the $|Z_{r_1}-Z_{r_2}| = \pm.924$ at the $\alpha = .05$. From the correlation values as shown in Table VI for T-1 and T-2, the results indicated that there are significant differences on the correlation of the attitude toward microcomputers in education x oneself (ATE x ATO) in T_1 and T_2 at the .05 level of significance. Also there are significant differences on the correlation of the attitude toward microcomputers in education x total (ATE x Total) in T_1 and T_2 at the .05 level of significance.

Correlation between the Knowledge Scale and Attitude Scale

By using the same procedure as mentioned above, there are no significant differences on the correlation of two scales between the microcomputer knowledge scale and attitudes toward microcomputer scales

TABLE VI

Correlation Value r and Z_r Between Scales of Attitudes toward Microcomputers

Scales (posttest only)	Pearson Correlation Values r and Z_r for T-1 and T-2					Prob.
	r_1	r_2	Z_{r_1}	Z_{r_2}	$Z_{r_1}-Z_{r_2}$	
ATE x ATS	.88	.67	1.398	.811	.587	N.S.
ATE x ATO	.84	.30	1.238	.310	.928	.05
ATE x Total	.96	.75	1.946	.970	.973	.05
ATS x ATO	.81	.81	1.113	1.113	.000	N.S.
ATS x Total	.94	.97	1.697	2.092	-.395	N.S.
ATO x Total	.94	.84	1.738	1.221	.517	N.S.

ATS = Attitudes toward computers in science

ATE = Attitudes toward computers in education

ATO = Attitudes toward computers by oneself

The critical value = ±.924 at the .05 (α) level of significance.

in science, education, by oneself, and total for T_1 and T_2 at the .05 level of significance, as shown in Table VII.

The correlation among the four dependent variables for each treatment group and for the combined group, together with the "critical values of the correlation coefficients," are found in Table VII. This means that if the absolute value of a given correlation coefficient is greater than the "critical value of the correlation coefficient," then the test is significant at the indicated level.

The purpose of these correlations was to find out the common characterization of the total scale and three subcomponents of attitude scale, and between the microcomputer knowledge scale and the attitude scale. These correlations might suggest some common factors of the instruments which were employed for this study.

Table VII

Correlation Value r and Z_r Between the Microcomputer Knowledge Scale and Attitudes toward Microcomputer Scales

Scales (posttest only)	Pearson Correlation Values r and Z_r for T-1 and T-2					Prob.
	r_1	r_2	Z_{r_1}	Z_{r_2}	$Z_{r_1}-Z_{r_2}$	
Knowledge and Attitudes						
1) Knowledge x Science	.63	.33	.741	.348	.393	N.S.
2) Knowledge x Education	.48	-.10	.530	-.010	.540	N.S.
3) Knowledge x Oneself	.44	.40	.466	.418	.048	N.S.
4) Knowledge x Total	.53	.26	.590	.266	.324	N.S.

N = number of subject for each correlation value

N_1 = 12 for T-1

N_2 = 12 for T-2

The critical value = ±.924 at the .05 (α) level of significance.

CHAPTER V

CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

Introduction

This chapter includes a statement of the problem studied, a listing of the hypotheses tested, an explanation of the procedures followed, a summary of the results established, conclusions, a discussion of the findings reported, and a list of suggestions for further research.

Statement of the Problem

The purpose of this study was to determine the relative effects of two modes of microcomputer instruction on science education students' knowledge in computer programming and their attitudes toward microcomputers. This study was designed to answer the following questions:

1. Are there differences on mean scores of knowledge in computer programming across the two types of instruction?

2. Are there differences on mean scores of microcomputer attitude scores in science across the two types of instruction?

3. Are there differences on mean scores of microcomputer attitude scores in education across the two types of instruction?

4. Are there differences on mean scores of microcomputer attitude scores for oneself across the two types of instruction?

Hypotheses

The hypotheses for this study were based on the questions previously identified under the statement of the problem. There were two modes of microcomputer instruction: E_1 subjects received a teacher-guided approach which included formal human instruction, practice with the microcomputer, use of an instructional canned program, and printed materials on computer programming (T-1). E_2 subjects were provided an independent learning approach involving practice with the microcomputer coupled with printed materials on computer programming but without formal human instruction or an instructional canned program (T-2), as shown in Appendix C.

Hypothesis 1

There will be no difference between the mean scores on the MKT of E_1 subjects who followed T-1 and the mean scores on the MKT of E_2 subjects who followed T-2.

Hypothesis 2

There will be no difference between the mean ATS scores of E_1 subjects who followed T-1 and the mean ATS scores of E_2 subjects who followed T-2.

Hypothesis 2.2

There will be no difference between the mean ATE scores of E_1 subjects who followed T-1 and the mean ATE of E_2 subjects who followed T-2.

Hypothesis 2.3

There will be no difference between the mean ATO scores of E_1 subjects who followed T-1 and the mean ATO of E_2 subjects who followed T-2.

Procedures

The research design in this study was an experimental design with posttest only. Twenty-eight volunteers enrolled in a senior level science methods course at a large eastern university were randomly assigned to one of two instructional treatments (T-1 and T-2). The sample was twenty-four subjects present at the orientation microcomputer workshop and each of the four 95-minute sessions held Monday through Thursday evenings. The treatment period for each group was three weeks in length. Subjects who missed one or more sessions were not eligible for hypothesis testing.

The subjects were randomly assigned to one of two experimental groups (E_1 or E_2) for instructional treatment. Group E_1 received a teacher-guided approach which included formal human instruction, practice with the microcomputer, use of an instructional canned program, and printed materials on computer programming (T-1). Group E_2 was provided an independent learning approach involving practice with the microcomputer coupled with printed materials on computer programming without formal human instruction or an instructional canned program (T-2) as shown in Appendix C.

Prior to the treatment periods, both groups had the identical two-hour orientation workshop. Each subject had an opportunity to have "hands-on" experience with the microcomputer and interact with it using an introductory program. Thus, each subject in the two groups received the same background information. The purpose of the orientation workshop was to provide the standard introduction.

The Apple II microcomputer was used in this study. It is a general-purpose microcomputer system which is versatile and reliable. The components of the Apple II microcomputer consist of a typewriter keyboard, central processing unit and built-in memory (48 kilo bytes), diskette drive unit, and visual display unit or cathode ray tube. These components are the minimum required to operate the Apple II microcomputer system.

The literature reviewed did not provide a test to measure the acquisition of the microcomputer knowledge in computer programming which is appropriate for this study. The researcher, therefore, designed the Microcomputer Knowledge test which was a set of 30 completion questions (total possible points = 76).

Campbell and Stanley's (1966) Posttest-only Control Group Design was used for this study. Data collected to measure the four dependent variables of this research were analyzed using the Behrens-Fisher t'-test and the Fisher's Z-transformation and an $\alpha = .05$ was accepted. Three statistical packages were utilized in this study: RELIB, LIKERT and SPSS.

Results

Testing the hypotheses cited earlier, the results are:

1. T-1 did not produce a significantly different mean MKT than T-2.

2. T-1 did not produce a significantly different mean ATS than T-2.

3. T-1 did not produce a significantly different mean ATE than T-2.

4. T-1 did not produce a significantly different mean ATO than T-2.

Conclusions

The following conclusions seem warranted:

1. The knowledge in computer programming was similar for both treatments.

2. Attitude score was similar for both treatments.

Discussion

The findings of this study suggest that subjects provided printed materials, minimum human instruction and without instructional canned program seem to do as well on computer programming knowledge as subjects who, in addition to printed materials, had an instructional canned program, a high level of formal human instruction, but less practice time on the microcomputer. The findings for attitude scores were similar.

Hansen, Dick, and Lippert (1968) reported results when using CAI to handle problem sessions in a college physics course. Results showed that the all-CAI group did significantly better than the other groups on the achievement measures. The results of this study failed to show such an advantage of a predominantly CAI treatment.

Edward et al. (1975) in the summary of reviewed research reported nine studies have shown that CAI as a supplement to formal human instruction is more effective than human instruction alone. The findings of this study show no clear advantage of high or low level of human instruction in computer learning.

If subsequent studies with greater numbers of subjects were to generate results consistent with this study, one could begin to question the common assertion that high instructor profile or an instructional canned program are necessary to foster positive attitudes of subjects toward computers. One could also begin to question the need for the added work of direct human instruction and canned programs.

Suggestions for Further Research

1. To determine the generalizability of the results, this study should be replicated with greater numbers of subjects and with other target populations.

2. Further study should be conducted to test the following variables separately:

   (a) practice time;

   (b) human instruction or traditional assisted non-computer instruction;

(c) canned programs; and

(d) printed materials.

3. Further studies should be conducted to determine the relative effects between CAI as a supplement or complement to high formal human instruction and high formal instruction alone.

APPENDIX A

ATTITUDES TOWARD COMPUTER SCALE

Name____________________

Date________________

Attitudes Toward Computers*

The purpose of this questionnaire is to find out what you think about computers. First, please give the following information.

Check one of the following:
______ A. I have never used a computer.
______ B. I have used a computer, but less than five times.
______ C. I have used a computer more than five times.

On the following pages there are different topics for you to describe. Your description can be made by marking the list of words on the page. Each pair of words goes together. For example, if the topic were "Use of Computers in Education," you might feel that the word "good" describes "Use of Computers in Education" better than "bad." Your answer would look like this:

good |_x_|___|___|___|___|___|___| bad

Or, you might feel that both words describe the topic "Use of Computers in Education" equally well. Then your answer would look like this:

good |___|___|___|_x_|___|___|___| bad

You might feel that "bad" is a better description of "Use of Computers in Education" than "good." Then your answer would look like this:

good |___|___|___|___|___|___|_x_| bad

Never put more than one mark for each pair of words, but be sure to mark every pair of words.

Do not spend more than a few seconds on each pair of words.

If you have any questions, ask them now before you begin.

*Semantic Differential Scale from Shirey's Attitudes Toward Computers.

Name____________________

Date__________________

The Use of Computers in science

good								bad
strange								unfamiliar
foolish								wise
simple								complicated
valuable								worthless
unsuccessful								successful
important								unimportant
unpredictable								predictable
mysterious								understandable
confusing								clear

. . . .

How would you feel about using a computer yourself?

good								bad
strange								familiar
foolish								wise
simple								complicated
valuable								worthless
unsuccessful								successful
important								unimportant
unpredictable								predictable
mysterious								understandable
confusing								clear

Name________________

Date________________

<u>The Use of Computers in Education</u>

good								bad
strange								familiar
foolish								wise
simple								complicated
valuable								worthless
unsuccessful								successful
important								unimportant
unpredictable								predictable
mysterious								understandable
confusing								clear

....

APPENDIX B

MICROCOMPUTER KNOWLEDGE TEST

Name ____________________

Date ____________________

Microcomputer Knowledge Test

1. What is the typical data processing operation?

   Score
   ______ 2 points

2. The four basic components (configuration) of a computer system are:

   Score
   (a) ______ 1
   (b) ______ 1
   (c) ______ 1
   (d) ______ 1

3. What is the function of a storage unit or internal memory?

   Score
   ______ 2

4. What are the functions of a CPU (or central processing unit)?

   Score
   (a) ______ 1
   (b) ______ 1
   (c) ______ 1

5. We communicate to the Apple II by using (a) __________. called (b) __________

   Score
   (a) ______ 2
   (b) ______ 2

6. A set of instructions that tells the microcomputer what to do and how to do it is __________.

   Score
   ______ 2

7. A computer program someone has written, checked, and stored on a diskette, disk, magnetic tape, or cartridge for other people to use is called a(an) ___________.

Score
______ 2

8. What is the sequence of commands that we use to access the canned program?

Score
(a) _____ 1
(b) _____ 1
(c) _____ 1

9. If you type this program on the keyboard of the Apple II and then you type RUN and press RETURN, what is the output of this program?

```
10 REM    THIS IS A SIMPLE PROGRAM
20 PRINT  "PENN STATE NUMBER"
30 PRINT
40 PRINT
```

Score
(a) _____ 1
(b) _____ 1
(c) _____ 1

10. What is the result of this program?

```
 5 LET    T=16
10 PRINT  "P=", 2*T
20 END
```

Score
______ 2

11. Which command do you use to clear the memory but not clear the monitor or CRT screen?

(a) HOME
(b) CLEAR
(c) NEW
(d) LIST

Score
______ 2

12. What is the output of the following program?

```
10 REM    *TEMPERATURE CONVERSION*
20 REM    *C=(F-32)/9*5*
30 LET    F=59
40 LET    C=((F-32)/9)*5
50 PRINT  C
Type RUN and hit RETURN
```

Score
______ 2

13. From question 12, if you type lines like this -- 30 INPUT F-- then you type RUN and hit RETURN, what is the display on the screen?

Score
______ 2

14. What is the output of the following program? How can we stop the execution of this program?

```
 5 REM      AN INTRODUCTORY PROGRAM
10 PRINT    "BOB"
20 PRINT    "HOW ARE YOU?"
40 GO TO 10
Type RUN and hit RETURN
```

Score
(a) _____ 2
(b) _____ 2

15. If you want to store the written program on the diskette, what type of command do you use? (Give an example)

Score
______ 2

16. If you enter a program in this order:

```
30 IF A=2 THEN PRINT "NO"
10 INPUT A
40 IF A=3 THEN PRINT "MAYBE"
20 IF A=1 THEN PRINT "YES"
50 END
```

(a) Can the computer run the program?
(b) What command can we use to make these lines be in order?

	Score
(a) _____	2
(b) _____	2

17. If you use the computer, show what a run will look like on your screen.

```
110 LET P=1
120 PRINT 2*P
130 LET P=P+1
140 IF P>4 THEN GO TO 160
150 GO TO 120
160 END
```

	Score
_____	4

18. (a) What is the variable in the above program? (b) How many times does the statement GO TO pass control to line 120?

	Score
(a) _____	2
(b) _____	2

19. What will the computer print if given the following command?

```
PRINT  (95-14/2)+7*10
```

	Score
_____	2

20. What is the order of arithmetic in BASIC language (from highest priority to lowest) without parentheses?

	Score
_____	2

21. What word is used to label a statement in a program? (Give an example)

Score
______ 2

22. How can you delete a line in a program?

Score
______ 2

23. Which of these is a variable?

(a) 1.75
(b) 000
(c) B
(d) Z9
(e) Both (c) and (d)
(f) All of these

Score
______ 2

24. Which of these will print a whole number?

```
10 REM    INTEGER
20 PRINT  8*3/5
30 PRINT  INT (4.8)
40 PRINT  ABS (-19.7)
50 END
```

Score
______ 2

25. Which of these will give you the square root of 9?

```
 5 PRINT  INT (9)
10 PRINT  SQT (9)
15 PRINT  SQR (9)
20 PRINT  ABS (9)
```

Score
______ 2

26. How can you get a random number between 1 and 60 in Applesoft?

(1)
```
 5 LET    A=RND(1)
10 LET    A=A*60
15 PRINT  INT(A)
```

(2)
```
10 LET    A=RND(60)
20 PRINT  A=INT(A)
30 PRINT  A
```

______ Score / 2

27. What will the program print?

```
10 LET    C=35
20 LET    C=C+40
30 PRINT  C
40 END
```

______ Score / 2

28. What command do we use to display lines 20 through 60 of this program?

```
10 LET    S=14
20 LET    A=S*S
30 PRINT  "AREA OF A SQUARE"
40 PRINT  "SIDE+"
50 PRINT  S
60 PRINT  "AREA+"
70 PRINT  A
80 END
```

______ Score / 2

29. If you use the computer, show what a RUN will look like on your screen.

```
10 LET B=11
20 LET B=B-1
30 PRINT B
40 IF B=0 THEN GO TO 60
50 GO TO 20
60 PRINT "BLASTOFF!!!"
60 END
```

______ Score / 3

30. Which line in the above program modifies a counter?

______ Score / 2

Key

1. Input → Data Processing → Output

2. (a) Input unit
   (b) Microprocessor unit or processor unit or central processing unit or CPU
   (c) Storage unit or memory unit or internal memory
   (d) Output unit

3. Store both information and instruction (until needed).

4. Interpret instructions
   Control their execution
   Perform all the calculations

5. (a) Computer language
   (b) BASIC or PASCAL

6. A BASIC program or a PASCAL program or a computer program

7. Canned program

8. (a) CATALOG
   (b) LOAD program name
   (c) LIST or RUN

9. (a) PENN STATE NUMBER
   (b) Blank line
   (c) 1

10. P = 32

11. (c) NEW

12. 15.

13. ? (question mark)

14. (a) Endless loop
    (b) Press CRTL and hold C down, or press RESET

15. SAVE program name

16. (a) Yes
    (b) LIST

17. 2
    4
    6
    8

18. (a) p
    (b) 3 times

19. 18

20. Multiplication, division, addition, and subtraction.

21. REM characters

22. Type the line number and hit RETURN

23. (e)

24. PRINT INT (4.8) or line 30

25. PRINT SQR(9)

26. (1)

27. 75

28. LIST 20-60

29. 10
     9
     8
     .
     .
     .
     1
     BLASTOFF!!!

30. Line 20

Table VIII

Questions for the Microcomputer Knowledge Test
Drawn from Teaching Sessions

Question	Sessions	Question	Sessions
1	11	16	5,6
2	11	17	6,7
3	11	18	7
4	11	19	2
5	1	20	2
6	11	21	8
7	11	22	3
8	3	23	5
9	2,10	24	9
10	3,4,5	25	9
11	3	26	4,9
12	4	27	3,4,5
13	5	28	3,4,5,10
14	6,8	29	7
15	3	30	7,8

APPENDIX C

INSTRUCTION PLAN FOR TWO TREATMENTS, T-1 AND T-2

Plan 1 for T-1 (Teacher-Guided Approach)

Session 1

Objectives

Each subject will learn (pp. 4-5):

1. The computer terminal's keyboard.
2. What the computer memory looks like.
3. Interpreter
4. BASIC words
5. PRINT statements and RETURN key.

Materials

Each subject will be provided with an Apple II microcomputer, instructional canned program on a diskette or floppy disk coupled with learning materials which contain lessons 1-5, and pencil and paper.

Procedure

1. Conduct a general discussion according to the outline of the objectives (30 minutes).
2. Each subject follows the menu-driven displays on the CRT screen from summary of lesson 1, part 1 to practice problem of lesson 1, part 1.

Session 2

Objectives

Each subject will learn (pp. 6-7):

1. Arithmetic using PRINT.
2. Order of arithmetic operation.
3. Order of arithmetic operation when parentheses are used.

Materials

Same as Session 1.

Procedure

1. Conduct a general discussion according to the outline of the objectives (30 minutes).
2. Each subject follows the menu-driven displays on the CRT screen from summary of lesson 1, part 2 to practice problems of lesson 1, part 2.
3. RUN QUIZ 1 or self-test 1.

Session 3

Objectives

Each subject will learn (pp. 8-9):

1. A simple program
2. Line number
3. RUN command
4. LIST command
5. NEW command

6. DEL command
7. END command
8. STOP command
9. RETURN key

Materials

Same as Session 1.

Procedure

1. Conduct a general discussion according to the outline of the objectives (30 minutes).
2. Each subject follows the menu-driven displays on the CRT screen from summary of lesson 2, parts 1 and 2 to practice problems of lesson 2, parts 1 and 2.
3. RUN QUIZ 2 or self-test 2.

Session 4

Objectives

Each subject will learn (pp. 10-13):

1. LET instruction sets a variable.
2. PRINT instruction and variable.

Materials

Same as Session 1.

Procedure

1. Conduct a general discussion according to the outline of the objectives (30 minutes).
2. Each subject follows the menu-driven displays on the CRT screen from summary of lesson 3, part 1 to practice problem of lesson 3, part 1.

<u>Session 5</u>

Objectives

Each subject will learn (pp. 13-14):

1. INPUT statement and variable.
2. Format of INPUT statement.

Materials

Same as Session 1.

Procedure

1. Conduct a general discussion according to the outline of the objectives (30 minutes).
2. Each subject follows the menu-driven displays on the CRT screen from summary of lesson 3, part 2 to practice problem of lesson 3, part 2.
3. RUN QUIZ 3 or self-test 3.

Session 6

Objectives

Each subject will learn (pp. 14-15):

1. GOTO statement.
2. An infinite loop with GOTO.
3. To break loop with CTRL key while pressing the key for letter C.

Materials

Same as Session 1.

Procedure

1. Conduct a general discussion according to the outline of objectives (30 minutes).
2. Each subject follows the menu-driven displays on the CRT screen from summary of lesson 3, part 1 to practice problem of lesson 4, part 1.

Session 7

Objectives

Each subject will learn (pp. 16-18):

1. IF-THEN and GOTO statements on a certain condition.
2. Summary of signs (=, <, >, etc.) which can be used in a computer program.

Materials

Same as Session 1.

Procedure

1. Conduct a general discussion according to the outline of the objectives (30 minutes).
2. Each subject follows the menu-driven displays on the CRT screen from summary of lesson 4, part 2 to practice problems of lesson 4, part 2.
3. RUN QUIZ 4 or self-test 4.

Session 8

Objectives

Each subject will learn (pp. 18-21):

1. How to set up the Counters by using a LET statement.
2. REM statement (tells BASIC interpretation to ignore this line).

Materials

Same as Session 1.

Procedure

1. Conduct a general discussion according to the outline of the objectives (30 minutes).
2. Each subject follows the menu-driven displays on the CRT screen from summary of lesson 5, part 1 to practice problems of lesson 5, part 1.

Session 9

Objectives

Each subject will learn (pp. 21-23):

1. Library functions:

   X = INT (y)

   X = ABS (y)

   X = RND (1)

   X = SQR (y)

2. Nested parenthesis

3. Other library functions:

   X = SIN (y)

   X = COS (y)

   X = TAN (y)

   X = ATAN (y)

   X = LOG (y)

4. ENTER and RUN some sample programs.

Materials

Same as Session 1.

Procedure

1. Conduct a general discussion according to the outline of the objectives (30 minutes).
2. Each subject follows the menu-driven displays on the CRT screen from summary of lesson 5, part 2 to practice problems of lesson 5, part 2.
3. RUN QUIZ 5 or self-test 5.

Session 10

Objectives

Each subject will learn (pp. 23-25):

1. HOME instruction.
2. PRINT command causes a blank line.
3. PRINT command with comma and semicolon.
4. TAB command.

Materials

Same as Session 1.

Procedure

1. Conduct a general discussion according to the outline of the objectives (30 minutes).
2. Each subject follows the menu-driven displays on the CRT screen from summary of lesson 6, part 1 to practice problem of lesson 6, part 1.
3. RUN QUIZ 6 (sample part).

Session 11

Objectives

Each subject will learn (pp. 1-20) the hardware:

1. To understand that the computer is a valuable tool that can solve problems, print words, draw pictures, store information, retrieve information, compare information, play games, etc.

2. To identify the basic components (or computer configurations) of a general-purpose computer system.
3. To identify and explain the functions of the basic components of an Apple II microcomputer.
4. To define and explain the terms hardware, software, microcomputer, microprocessor, RAM, ROM, processor, input unit, output unit, and binary.

Materials

Same as Session 1.

Procedure

1. Conduct a general discussion according to the outline of the objectives (30 minutes).
2. Self-testing.

Plan 2 for T-2 (Independent Learning Approach with Minimum Human Instruction)

Session 1 - Session 11

Objectives

Each subject follows the same objectives of Plan 1 for T-1 from Sessions 1-11.

Materials

Each subject has the same materials as in Plan 1 for T-1 from Sessions 1-11, except the instructional canned program on a diskette or floppy disk.

Procedure

1. No formal instruction, with minimum human instruction.
2. Each subject follows the same lesson plan of the same materials as in Plan 1 for T-1 from Sessions 1-11, respectively.
3. Self-test the same as in Plan 1 for T-1 from Sessions 1-11.
4. Teacher was on call (see data on page 96).

Table IX

Number of Questions Asked by Subjects
Within a 15-minute Period
in Each Session for T-2

April 18	--	6	questions
" 19	--	4	"
" 20	--	2	"
" 21	--	9	"
" 25	--	4	"
" 26	--	2	"
" 27	--	3	"
" 28	--	5	"
May 2	--	2	"
" 3	--	4	"
" 4	--	3	"

Average number of questions asked in 15 minutes: 4.

Approximately 40 seconds required to respond to each question.

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