ABSTRACT

AN INVESTIGATION OF THE EFFECT OF TEACHING STRATEGIES ON COGNITIVE AND AFFECTIVE RESPONSES OF PRE-SERVICE TEACHERS TOWARD COMPUTERS

By

Sidney Fagan

The purpose of this study was to investigate the effects of two different teaching strategies upon the knowledge of, and attitude toward, computers of pre-service elementary and secondary school teachers. The population consisted of 280 pre-service elementary and secondary school teachers who were enrolled in a science methods class at Michigan State University during the Winter and Spring terms of 1971.

The first teaching strategy employed "Cardiac," a cardboard computer simulator designed by the Bell Telephone Laboratories, as the principle instructional tool. This experience gave the students a type of "hands-on" experience. The second teaching strategy used a variety of media to illustrate the hardware and software of a computer system. Included in this presentation were

35 mm slides, 8 mm film loops, overhead transparencies and pieces of demonstration equipment. There were also groups of both elementary and secondary pre-service school teachers to serve as control groups, engaging in activities totally unrelated to the computer.

Three evaluation instruments were used in this study. The first instrument, designed by the author, was a twenty item multiple choice examination which measured the participants' knowledge of computers. The second instrument consisted of twenty bi-polar adjectives to measure the subjects' attitude toward the concept "computer." The third evaluation consisted of a questionnaire to measure the participants' attitude toward computer-assisted instruction. These instruments were administered at the completion of the two-hour lesson on computers to all of the participants.

The pertinent findings of this study were:

1. When the classroom was considered the experimental unit, the elementary pre-service school teachers showed significant differences between the treatment groups and control groups in their knowledge of computers and attitude toward computers. There was also a fairly high correlation between gain in knowledge and more positive attitude toward computers in these classrooms. There was a negative correlation between attitude toward

computer-assisted instruction and gain in knowledge demonstrated by these classrooms.

2. When a two way analysis of variance was performed, using the elementary and secondary individuals as the experimental unit, the following findings were noted:

a. There was a significant difference between the elementary and secondary pre-service school teachers in their knowledge of computers and their attitude toward computers.

b. Both elementary and secondary pre-service school teachers gained equally from either of the two types of computer lessons.

c. There was no significant difference between the elementary and secondary pre-service school teachers' attitude toward computer-assisted instruction.

d. There was no significant correlation between any of the variables investigated in this study when the individual was the experimental unit.

e. There was a significant difference between the treatment and control groups in knowledge of computers and attitude toward computers.

f. There was no significant difference between the treatment and control groups in attitude toward computer-assisted instruction.

g. There was no significant interaction effect.

h. There was no significant item by group interaction on the measure of knowledge of computers.

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TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table | Page

LIST OF FIGURES

## LIST OF APPENDICES

Appendix. Page

CHAPTER I

# INTRODUCTION

The major purpose of this study was to investigate the effect of several teaching strategies upon the knowledge and attitudes toward computers of pre-service elementary and secondary school teachers.

Two approaches to teaching about the computer were used with these pre-service elementary and seconday school teachers. The first approach involved the use of "Cardiac" (an acronym for the Bell Telephone Teaching Aid) as the major teaching tool. It was felt that this might simulate a "hands-on" experience for the participants. The second approach involved the use of various media to teach about the computer. Included in this second technique were 35 mm slides, 8 mm film loops, and overhead transparencies, as well as some demonstration devices.

Evaluation instruments were administered at the end of each treatment and an analysis was conducted to determine the effect of these treatments upon the participants' knowledge of computers.

To clarify the effect of these treatments upon the subjects' attitudes, measures of their attitude toward computers and attitudes toward computer-assisted instruction were also administered.

The relationships that existed between the variables of this study were examined. The implications of these relationships and their possible consequences for the educational institutions which train teachers were studied.

It was hoped that the findings of this study would give educators a greater insight into the ways prospective teachers perceive the computer as a machine and as a potential teaching aid.

> These new technologies are knocking at the schoolhouse door, and computers are beginning to have a powerful impact on all educational fronts. Many educators are firmly convinced that within the next few years we will see these remarkable instruments, the computers, bring about a revolution in the classroom and in the entire educational process. This will be equivalent to the one already wrought by computers in science and industry. (1)

## Education and the Computer Today

Many educators concur that each passing year will strengthen the merger between education and the computer industry. This partnership will be evident at all levels of education and technology. Alexander Schure has stated:

> The use of the computer will alter the face of education and indeed civilization. The computer will be imbedded as a prime foundation stone in the schools, education centers, and universities of tomorrow. It will be a tool used locally within the classrooms as

> well as a management device to administer larger regional schools. (2)

Computers are already in many school systems for one use or another. A large number of urban schools now have a vice-principal or other administrative officer whose specific job is to coordinate the preparation of schedules, grades, budgets, or test scores for the computer. Some school systems' financial transactions are completely computerized. Although many of these preparations were originally processed by administrators alone, as the computer's use became more widespread, within a school system, some of these tasks have filtered to individual teachers and secretaries. On occasion this expansion involves the use of hitherto unfamiliar equipment. Often teachers must attend several meetings to orient themselves in the use of this equipment or these techniques. It seems quite likely that the use of the computer as a management tool will continually increase.

The use of the computer at the instructional level also will rise sharply, according to numerous educators. Alfred Bork recently wrote:

> Nearly every journal concerned with education today includes articles extolling the computer as a teaching device. I am quite sympathetic toward this literature. As many aspects of education involve information handling and information transfer, and as the computer is an extremely effective device for storing and manipulating information, the computer will be usable in a wide variety of ways in education.

> Furthermore, it has considerable intuitive value for many students. (3)

In the near future it is possible that many of today's pre-service teachers will have some contact with what is commonly called computer-assisted instruction. Yet most will be unprepared. As Alpert and Bitzer point out (4), national commitment to education is expected to double by 1980. There are growing demands for more mass education and for individual instruction tailored to the specific needs of a given student.

It is not surprising, therefore, that there has been a widespread search for technology to assist in this dilemma. The high-speed computer, in the hands of a prepared teacher, seems particularly suited to this need.

> The many programs in computer-assisted instruction have been based on recognition of the unique value of the computer in adapting the selection and presentation of instructional materials to the pace and style of individual students and in acquiring and processing data relating to the effectiveness of the teaching and learning processes. Nevertheless, although some of these programs have met with great enthusiasm on the part of highly qualified educators, it is fair to say that the general reaction has been mixed. (5)

## Attitude toward Technology

The reasons for such mixed reactions have been many and varied. These reasons include false notions as to what is truly feasible, a wide diversity of objectives, and the misconceptions and misunderstandings that seem to become prevalent whenever the computer is mentioned. The misconceptions have often led to a negative attitude by those directly involved with the use of computer-assisted instruction with their students. This study has investigated the effect of exposure to basic computer facts and its affect upon these negative attitudes.

The teacher's attitude toward technology and more specifically computer-assisted instruction cannot be ignored. Jerman and Anastasiv have stated:

> The attitude of the teacher is a very important factor in determining the attitude students will bring to their work on the terminals. (6)

There have been several studies that have investigated teachers' attitudes toward technology and automated instruction. Three such studies by Sigmond Tobias lead to these conclusions. After his initial study, Tobias stated:

> The data strongly suggested that teachers were biased against terms implying automation and indicated the possibility that teachers viewed such media as threatening to their role. (7)

At the conclusion of this third study, Tobias summarized as follows:

> This finding confirmed previous results (Tobias 1963, 1966), indicating that teachers have significantly less favorable attitudes toward terms which directly connote automation than they do to comparable terms which are not identified with automation. (8)

## Statement of Problem

The problem was to investigate the effect of two teaching strategies upon selected cognitive and affective aspects of pre-service elementary and secondary school teachers at Michigan State University toward computers and computer-assisted instruction. The study included the following areas:

1. The attitudes of pre-service elementary and secondary school teachers toward the computer as measured by a semantic differential scale.
2. The attitudes of pre-service elementary and secondary school teachers toward computer-assisted instruction as measured by a questionnaire.
3. The knowledge of computers of pre-service elementary and secondary school teachers as measured by a multiple choice cognitive instrument.

These data were analyzed to answer the following questions:

1. Can a short term lesson on computers using "Cardiac" (see definition of terms) cause a significant change in
    a. pre-service elementary school teachers' overall attitude toward computers?
    b. any selected aspect of pre-service elementary school teachers' attitudes toward computers?

c. pre-service secondary school teachers' overall attitude toward computers?

d. in any selected aspect of pre-service secondary school teachers' attitude toward computers?

e. pre-service elementary school teachers' overall attitude toward computer-assisted instruction?

f. pre-service secondary school teachers' overall attitude toward computer-assisted instruction?

g. pre-service elementary school teachers' knowledge of computers?

h. pre-service secondary school teachers' knowledge of computers?

2. Does a short term lesson on computers using a multi-media presentation cause a significant change in

   a. pre-service elementary school teachers' overall attitude toward computers?

   b. pre-service secondary school teachers' overall attitude toward computers?

   c. any selected aspect of pre-service elementary school teachers' attitude toward computers?

d. any selected aspect of pre-service secondary school teachers' attitude toward computers?

e. pre-service elementary school teachers' attitude toward computer-assisted instruction?

f. pre-service secondary school teachers' attitude toward computer-assisted instruction?

g. pre-service elementary school teachers' knowledge of computers?

h. pre-service secondary school teachers' knowledge of computers?

3. Is there any significant correlation between changes in knowledge and changes in attitude caused by a short term lesson using "Cardiac" with pre-service elementary school teachers?

   b. Is there any significant correlation between changes in knowledge and changes in attitude caused by a short term lesson with "Cardiac" in pre-service secondary school teachers?

4. a. Is there a significant correlation between changes in knowledge and changes in attitude caused by a short term lesson using

a multi-media presentation with pre-service elementary school teachers?

b. Is there a significant correlation between changes in knowledge and changes in attitude caused by a short term Cardiac lesson using a multi-media approach with pre-service secondary school teachers?

5. a. Are greater changes in knowledge caused by a short term lesson on computers using "Cardiac" or are greater changes in knowledge caused by a short term lesson on computers using a multi-media presentation with pre-service elementary school teachers?

b. Are greater changes in knowledge caused by a short term lesson on computers using "Cardiac" or are greater changes in knowledge caused by a short term lesson on computers using a multi-media presentation with pre-service secondary school teachers?

6. a. Are greater changes in attitude caused by a short term lesson on computers using "Cardiac" or are greater changes in attitude caused by a short term lesson on computers using a multi-media presentation with pre-service elementary school teachers?

b. Are greater changes in attitude caused by a short term lesson on computers using "Cardiac" or are greater changes in attitude caused by a short term lesson on computers using a multimedia presentation with pre-service secondary school teachers?

7. Does a short term lesson on computers using "Cardiac" cause a greater change in

   a. knowledge of computers in pre-service elementary school teachers or pre-service secondary school teachers?

   b. attitude toward computers in pre-service elementary school teachers or secondary school teachers?

   c. attitude toward computer assisted instruction in pre-service elementary school teachers or pre-service secondary school teachers?

8. Does a short term lesson on computers using a multi-media presentation cause a greater change in

   a. knowledge of computers in pre-service elementary school teachers or pre-service secondary school teachers?

b. attitude toward computers in pre-service elementary school teachers or pre-service secondary school teachers?

c. attitude toward computer-assisted instruction in pre-service elementary school teachers or pre-service secondary school teachers?

## Definition of Terms

The term Cardiac refers to a science teaching aid developed by the Bell Telephone Laboratories. The word Cardiac is an acronym for CARDboard Illustrative Aid to Computation. It is a cardboard device with sliding panels which have numbers printed on them. When these panels are manipulated according to instructions, numbers appear in "windows" on the face of the cardboard. These numbers attempt to show how data and instructions flow through the computer system.

The phrase multi-media presentation refers to a method of instruction in which subject matter is presented through the use of slides, film loops, audio-cassette tapes, overhead projection and lecture.

The term computer assisted instruction refers to a method of instruction in which subject matter is presented by a computer. The person is instructed and makes responses by means of a "terminal," usually a device similar to an electric typewriter.

The phrase attitude toward computers refers to the subject's score on the semantic differential scale testing the concept "Computer."

The term attitude toward computer assisted instruction refers to the subject's score on the attitude scale used to measure attitude toward computer assisted instruction.

The phrase knowledge of computers refers to the subject's score on the cognitive instrument titled "The Computer--A multiple choice examination.

The term pre-service elementary teacher refers to students enrolled in Ed. 325F--"Teaching Science in the Elementary School" at Michigan State University, Winter term, 1971.

The phrase pre-service secondary teacher refers to students enrolled in ED. 327S--"Methods of Teaching Secondary Science" at Michigan State University, Winter term, 1971.

## Need for Study

> We cannot ignore the fact that technology does offer us hitherto undreamt of possibilities. (9)

If the view above is shared by such large numbers of highly qualified educators and technologists, why then has not educational technology made a real impact upon our educational system? The computer in particular has been compared to "Gutenberg's invention of the printing press in terms of the potential effect it will have upon education." (10) Yet, to date, the computers' contributions to classroom instruction have not been substantial. In a report to the President by the Commission on Instructional Technology, the following passage makes this perfectly clear.

> Today, there are fewer than 1,000 computer-assisted instruction terminals serving fewer than 20,000 public school students. When we subtract from these totals terminals and students involved in limited experimental and demonstration projects, we find that the parameters of operational computer-assisted instruction shrink to less than 500 terminals and 16,000 students. (11)

Although there have been relatively few valid studies as to the effectiveness of computer-assisted instruction as a teaching strategy, those studies that are available show great promise for such instruction. Lawrence M. Stolurow, director of the Harvard Computer-Aided Instruction Laboratory warns, however, that any predictions made at this time are purely speculative. He states:

> Projections based upon today's systems would have the same degree of fidelity as projections based upon the Wright brothers first plane would have had for predicting the design of the supersonic transport. (12)

Yet when administrators and boards of education do adopt plans for innovative change, often involving the use of new programs, new equipment and new technology, the teacher is not properly trained in either the use or philosophy of these changes and equipment.

> If there is one thing the teacher, particularly the female teacher, is not, it is an engineer. Indeed it is difficult to think of two world views further apart than those symbolized by the Golden Rule on the one hand and the slide rule on the other. . . . they do give us pause when we consider the likelihood of increasing the dialogue between the tender-minded teachers and the tough-minded technicians. To say that they do not speak the same language is a gross understatement. (13)

When the newly adopted educational technique "fails" what is the cause? Was the program inappropriate, was the equipment too complex, or was this "failure" due to the inability of the teacher to internalize the philosophy necessary to implement effectively these new approaches? Was the teacher aware of all the uses or potential uses of this technology? Did the teacher have a negative attitude toward this machine before she ever started using it?

In an interview with the staff of the Commission of Instructional Technology, Jerrold R. Zacharias emphasized the importance of the teachers' predisposition toward educational technology by saying:

> Teachers exhibit a 'bistable' attitude with respect to the use of technology:
>
> If they haven't used it, or if what they've used has been irrelevant part of their busy schedules, they're sure they don't have time to use it.
>
> If, on the other hand, they <u>have</u> used it, and it has been a coherent part of a <u>full</u> set of learning aids, they say they don't have time <u>not</u> to use it. (14)

Evidence continues to support the conclusion that one of the most vital factors in preparation for the "Impending Instruction Revolution" as described by Harold E. Mitzel (15) is the teacher himself. Yet once the teacher leaves training at the university, it becomes increasingly difficult for him to obtain any formalized training about computers. Daniel Couger (16) investigated this problem and found that only through a combination of approaches could most schools get their instructors familiar with the use of computers and computer equipment. Some of these approaches included faculty seminars, computer manufacturer courses, courses sponsored by professional societies or other organizations and self-education. All of these approaches were tedious and not well received. The possibility of having instructors trained at the undergraduate level was obviously a much more effective approach.

A long range purpose of this study parallels, perhaps, the objectives of industry when they sponsor a "Personnel Services Seminar." The objectives of one of these seminars were:

1. Dispel the mystique surrounding computer personnel and technology.
2. Provide an appreciation for the type of work and problems that are faced by computer personnel.

3. Point the way for outside departments to gain more knowledge so that intelligent practices and policies can be applied. (17)

Applied to educational personnel, the attainment of these objectives would manifest themselves in a teacher fully prepared for this new technology of education.

Using students from an elementary science methods class and a secondary science methods class, two teaching strategies are used. Using a two way analysis of variance several multivariate hypotheses are tested. These hypotheses were intended to point up the effectiveness of the treatments, and the appropriateness of the material. Several relationships and correlations were also investigated.

## Overview

In Chapter II the pertinent literature on studies dealing with teachers' attitudes toward computers, computer-assisted instruction and educational technology have been reviewed.

In Chapter III the population is defined, statistical hypotheses stated, statistical models, which were used to test the hypotheses described, and the assumptions made in the statistical models delineated.

An analysis of data is found in Chapter IV along with tables to aid in the analysis of the hypotheses.

Chapter V is the summary and conclusion.

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# CHAPTER II

## BACKGROUND OF THE PROBLEM

Since the purpose of this study was to examine the effects of two teaching strategies on the attitude toward computers and the knowledge of computers of pre-service elementary and secondary teachers, pertinent literature was reviewed, particularly concentrating on the studies having a bearing on one or more of the areas in question.

The dichotomy of the computer in education is all too apparent. Even its critics will remark that these electronic devices have enormous potential in education, while its advocates also caution us as to its potential hazards. In an article entitled, "Will the Computer Kill Education," B. L. Hicks (1) first expresses the hope that computer programmers develop software that provides the student with meaningful experiences at a high level of instruction and second expresses the fear that computer-assisted instruction may attempt to "manufacture identical citizens on an educational assembly line." (2) He concludes his article by reminding us as educators:

> Whether the computer kills education will not be decided by the nature of the computer, but rather by the decisions we make about its use in education. (3)

## Cost of Computers for Education

It is claimed by some that the costs of computers and computer-assisted instruction will be so prohibitive as to keep this technology from ever making an impact upon education and therefore it would be meaningless to train teachers for this eventuality. In a recent paper Bell and Moon begin by stating:

> It would be unwise to consider any aspect of computer-assisted instruction as being a part of normal classroom operation without simultaneously considering cost. Financial feasibility of computer-assisted instruction is a subject which has been used both to support and discourage its use. Most often when financial feasibility is used in support of CAI, it is spoken of in terms of future applications. Because of these costs, present CAI systems have been justified in terms of special application, experimentation, and are cited as specific examples of methods of helping students who are not learning effectively under normal procedures.
>
> Not until experimentation and plans for the future are supplemented by tangible evidence of financial feasibility will CAI become much more than an experimental tool or novelty for the affluent or government-supported school systems. (4)

It is obvious that this state of affairs is likely to continue until computer systems and CAI can be developed whose cost will be consistent with other educational modes. The PLATO project at the University of Illinois has been exploring "the educational possibilities and the engineering and economic problems relating to the introduction of modern high-speed computer as an active element in the instructional process." (5) As the program has developed over the years, it has become the conviction of its developers that it can be operated at the hourly cost for the individual student of 25 cents per contact hour. It is felt that this system, along with its relatively low operating cost, "is clearly attainable in the early 1970's." (6)

Another approach on a somewhat different level, that a school teacher might be exposed to, is the stand-alone computer console. These consoles are now available for under $10,000 and are quite adequate for most uses at the secondary school level.

The essential trends with regard to cost of the high-speed computer in the educational process can no longer be denied. The cost of the contact hour per student is dropping, and will continue to drop, until the computer is available at rates accessible to most school systems.

Also of concern is the software of the computer systems; that is, the programs and teaching strategy they employ. If the participating teacher has no feeling for what they are, what they do, or how these programs accomplish the task, what motivation will he have to recommend them for his class. There are a great variety of approaches to computer software, ranging from Suppe's "Drill and Practice" (7) programs to inquiry approaches in which the student attempts to explain phenomena by using the computer as a resource tool to seek necessary information (e.g. RELAB--A special program in the PLATO project).

> The empirical research reported so far of comparative studies basic instructional variables and of individual differences is probably quite inadequate because of the CAI systems are so often being developed simultaneously and because terminal time is still often prohibitively costly. Thus, much or most of a research budget might be consumed by computer and telephone line costs. Nevertheless, the evidence clearly indicates that CAI will teach at least as well as live teachers or other media that there will be a saving in time to learn that students will respond favorably to CAI, that the computer can be used to accomplish heretofore impossible versatility in branching and individualizing instruction, that true nature instructional dialogue is possible and that the computer will virtually perform miracles in processing performance data. (8)

As evidence continues to support these findings, and as we develop through experience even more effective teaching programs, greater impetus is given to the movement that urges teacher education institutions to introduce computer technology to its prospective teachers.

R. W. Gerard (9), in his opening speech at a Computer and Education Workshop held at the University of California, Irvine, attempts to refocus the attention of those in attendance on the many ways in which the computer can be an enormous aid to the education of our young. He particularly notes how the computer itself parallels learning, and how it is able to manipulate countless pieces of information in a multitude of ways, arranging or sorting this information in any manner determined by that teacher. Relationships and correlations can be made available to any staff member. Gerard goes so far as to suggest:

> The cost of computerizing the whole of education bringing all those resources--all libraries and everything else into machine-handleable form, building the necessary programs for very rich Socratic tutorial interaction with the students would be paid for in a very few years. (10)

At a subsequent session of this conference, the vital questions relating to teachers' attitudes toward computers were discussed. R. C. Atkinson tells of a teacher training program he has used at Stanford University over the past years. Even the families of the involved teachers came to the computer laboratory to "play around" with the computers and their peripheral equipment. He felt that it was absolutely necessary that the teacher and computer be on an "intimate basis." (11)

Repeatedly, in session after session of this conference, the individual classroom teacher emerged as the single most vital factor in educational innovation. As one investigates the training of this teacher, he is impressed by the diverse backgrounds in both education and experience these people have brought with them. This heterogeneous class of freshmen is counseled and then placed into a program which has been designed to prepare them for their teaching careers. But what type of teaching career? Team teaching at the elementary level?

Non-graded classrooms? New laboratory oriented elementary or secondary curriculum projects? Or will these trainees eventually be placed in a situation where they will deal with the computer and computer-assisted instruction?

> To run these future teachers through a production mill is to do violence to their individuality and to deprive the schools of special talents that might be honed through individualized techniques. (12)

The computer, because of its ability to manipulate great volumes of information, could be used in the matching of prospective teachers who possessed particular aptitudes, talents, and interests with programs that were most compatible with these talents. Not only could the pre-service teacher benefit from being analyzed and scheduled by the computer, but also it has become evident that he also must learn about the computer.

> A crucial question needs to be considered--is it more important for people to be learning from computers or about computers? A review of CAI applications in elementary and secondary schools would indicate that the majority of efforts have been tutorial in nature. However, the growing use of computers in our culture indicates it is extremely important to learn <u>about</u> computers. Such a view has ample documentation in the Report of the President's Science Advisory Committee. (13) The ideal answer may be to learn about computers while learning from the computer. It appears some of the most financially feasible instructional uses of the computer may be those which also aid in an understanding of the computer. (14)

The value of the teacher learning "about the computer" can best be demonstrated by several studies which relate teachers' attitudes toward instructional media.

Sigmund Tobias conducted three studies seeking to investigate the relationships that existed between teachers' attitudes and instructional media. In 1963, he investigated teachers' attitudes toward three sets of terms; one set highly suggested automation, one suggested traditional teacher aids such as flash cards, film strips, and so forth, and the third set of terms referred to programmed instruction, but not automation as such. His results at that time indicated that the least favored attitudes were expressed toward terms connoting automation, followed by the terms suggestive of programmed instruction, while the traditional terms received the most favorable responses. Also, significant differences were found between essentially similar terms differing only in the degree to which they connoted automation. (15)

In a second study, Tobias attempted to derive more directly the degree to which fear of automation and other variables affected teachers' attitudes toward instructional media. Here again, teachers had a more negative attitude toward terms which most explicitly connoted replacement of the teachers' function. Also, however, there appeared a definite correlation between the lack of knowledge and negative attitude toward particular terms. (16)

Using a factor analysis, Tobias in 1967 investigated the dimensions of teachers' attitudes toward instructional media. Here again, his findings indicated that teachers

> Have significantly less favorable attitudes toward terms which directly connote automation than they do to comparable terms which are not identified with automation. (17)

Unfamiliarity also was found to be a factor which was related to negative attitude scores.

Similar results were obtained by Carol E. Barre in 1966. In his study, Barre attempted to determine the role which attitudes play in optimal interaction of humans with their machine systems. A semantic differential of 42 pairs of adjectives were used with concepts regarding a variety of different machines. The concepts rated were computer, radar, bicycle, and so forth. In his summary, Barre noted that respondents who tended to overrate machines thought of machines as having magical powers. That seemed to evolve out of a wish to have less and less responsibility in the operation of the machine. On the other hand, respondents who tended to be underraters had a basic distrust of machines and a fear of being replaced by a machine. (18) This finding parallels Tobias's study with teachers who also seemed to fear being replaced by a teaching aid or machine.

After conducting a comprehensive study of the educational scene, Charles E. Silberman (19) points up that teachers' fears of the computer's replacing them is unfounded. He states:

> There is reason to believe that the computer will change (emphasis added) the teachers' role and function rather than diminish his importance. (20)

Indeed, Silberman suggests that the use of the computer as an instructional tool is in the future of education, but, mainly due to excessive costs, in the somewhat distant future.

In his doctoral dissertation, A. I. Law (21) investigated the meaning that educational data processing had to teachers, pupil personnel workers, and administrators. His objectives were not to discover whether these groups accepted or rejected educational data processing, but to find if its meaning or perception was different within these selected groups. After administering a semantic differential questionnaire to these groups, he was unable to find any statistically significant difference in the meaning of educational data processing between groups. He felt that educational data processing had made no differential impact upon these groups. He summarized by stating:

> . . .Indeed the findings might suggest that there has been little, if any impact on the general educational community. The state of the art has not yet advanced to the point of materially affecting the educational program as it now exists. (22)

The studies cited to this point concern themselves with the respondents' knowledge and attitudes toward a type of instructional device without any controlled interaction between subject and instructional aid; in this case, the computer. Up to the present, most studies completed in this area of attitudes toward computers or computer-assisted instruction have been exploratory in nature, with the greatest emphasis being concentrated upon developmental work. There have been, however, some studies which confront the subject with the computer, usually through computer-assisted instruction, and then measure what effect this confrontation has had upon their cognitive and affective domains. In general, these studies have been more fruitful.

In a Master of Arts degree thesis, Paul Steinman (23) evaluated a statistics course that employed computer-assisted instruction as one of its teaching strategies. In the summer of 1969, at the University of Pittsburgh, Steinman, using a pre-test-post-test design, measured the attitudes of his participants towards two concepts: a neutral concept, radar; and computer. He administered an attitude instrument before his subjects started their treatment, and once again after they had completed their instruction in the statistics laboratory. His evaluative instrument was a twenty dimension semantic differential. As one might expect, there were no significant changes in any aspects of the subjects' attitudes toward the neutral concept radar. Several aspects of their attitudes did change, however, toward the concept "computer." Significant differences were found at the .05 level with the following adjective pairs from the semantic differential instrument testing the concept--"computer"; quickly outmoded--slowly outmoded, pleasant--unpleasant, necessary--unnecessary, and like--dislike. In all of the preceding adjective pairs, there was a statistically significant change toward the adjective that would seem to indicate a positive feeling about the computer. Many of the other adjective pairs also showed movement toward the more positive responses. However, they were not significant at the .05 level of significance. Steinman concludes:

> With respect to the computer with which students have had direct contact, the attitudes of the students toward the computer did change. Moreover, attitudes toward the computer reflect student understanding of the capabilities and limitations of the computer as a research tool. (24)

G. C. Christopher investigated the attitudinal effect of a computer-assisted experience on school administrators. (25) In his experimental design, the "treatment group" was to participate in the computer-assisted experience while the control group was not. Each group received a pre-test and post-test of an attitudinal measure. At the conclusion of the investigation, the mean score of the "treatment group" indicated a more favorable attitude toward computer-assisted instruction. The difference in the group means, as measured by a "t" test analysis, was significant at the $p < .02$ level.

> A further confirmation of favorable attitude changes as a result of CIU (computerized instructional unit) experience can be inferred from data provided by the professors and computer personnel involved in the study. . . The professors were asked if they would anticipate attitudinal change to occur among students after the CIU experience, and if so, in what direction this change would be. The professors concurred that favorable modification would occur. (26)

Robert Hart (27), a physicist at the New College of Hofstra University, introduced a short, self-designed computer unit into his physical science course. The students taking that course were mainly liberal arts majors who were required to enroll in this course for their degree. This unit on the computer and computer programming included three hours of lecture and two hours of actual time on the computer, an IBM 1130. In regard to his objectives for this introductory unit, Hart noted:

> The main object of the package is to give the students a feeling for the usefulness, accessibility, and humanistic and social implications of computers. This is subtler to evaluate than programming ability. . . I would expect the students' feelings that the computer is remote, daunting, vaguely threatening and inhuman. . . to decrease sharply. (28)

Hart's "instant computer course" required the students to write their own short computer programs using Fortran as a symbolic language, punch their own computer decks on a keypunch machine, and do whatever debugging was necessary in order to make their computer program run. At the conclusion of this five hour unit, a cognitive instrument was administered to the class. This instrument included tasks such as program writing, interpretation of error messages from a computer printout, debugging a program that would not run, and so forth. The mean grade on this exam was consistently 85%. Hart's study would seem to indicate that the basic computer concepts were not too difficult for this class of non-scientists and non-mathematicians.

In order to assess the impact of Hart's "instant computer course," a study was conducted by Melnick, Wahlert, and Yuker (29). Both a pre-test and post-test questionnaire were administered to 101 students who had just completed Hart's course. A 20 dimension semantic differential was used to measure attitudinal changes in several areas. In their analysis of the data, the researchers note:

> Of the eighteen differences whose direction suggests a more favorable computer image at posttest, fourteen are statistically significant while four are not . . . At post-test students studies tended to think of the computer as more: fast, worthwhile, good, beneficial, safe, rational, efficient, useful, approachable, interesting, accurate, understandable, easy to use, and productive than they did at pre-test, before they took the course. (30)

An analysis was also conducted as to the usefulness of the computer by various disciplines. The disciplines included in his analysis were humanities, natural science, social science, business, education and law. The students who were education majors felt that the computer was much more useful after they had completed Hart's course as compared to their feelings before taking this mini-unit on computers. In fact, their change in this dimension was significant at the $p < .02$ level with a higher "t" score than any other discipline. In response to the original question of the success of this computer course, the researchers replied:

> The impact of the computer course is to be seen in the apparent realization of some of the goals set forth at the outset--to convey the idea that computers are a good thing (the semantic differential shows a shift to a more positive image of the computer at post-test)--to impress students with the relevance of the computer in a wide variety of fields (there are significant changes in that direction too) and specifically to convey the feeling that the computer is approachable, not frightening. (31)

The researchers continue in their discussion:

> The findings seem to confirm the value of the course. . . Returning again to the strengths of the package to provide a frame of reference for its possible weaknesses, the most impressive attitudinal change seems to be a general one--an increased appreciation of the computer as an efficient and useful machine which was safe and easy to use. In terms of the more concrete teachings of the course a considerable number of students widened their views regarding the versatility of the computer's application. (32)

## Summary

In this chapter, the relationship of the teachers' attitude toward a variety of teaching aids was examined, with the major emphasis being placed upon the teachers' attitudes toward computers and computer-assisted instruction. Previous works, such as that of both Tobias and

Barre, indicate that the teacher does have doubts and anxieties as to his role in relation to a new teaching device. The importance of having a positive attitude has often been stressed by researchers and educational observers.

Lack of knowledge of a particular device has also been shown to decrease a teacher's willingness to incorporate that device into his classroom.

The last portion of Chapter Two concentrated upon various efforts and approaches that have been used with both classroom teachers and administrators and computers. In the assessments that followed these studies, it became clear that meaningful exposure to a formal, well constructed computer experience was able to affect statistically significant positive changes in the subjects' attitudes and knowledge both toward the computer and computer-assisted instruction.

Hart's (33) "instant computer course" and Melnick, Wahlert, and Yuker's (34) assessment of that course were particularly noteworthy. Hart's ability to effect such marked changes in regard to the computer with non-science oriented people, and in a very short period of time, indicates for this researcher that if the basic computer concepts are presented to these students in the proper framework and with a proper philosophy, positive changes can occur. One must keep in mind, however, that Hart's students did have an opportunity to work on a computer terminal.

Does this indicate then, that if a computer system is not available to an instructor, he will be unable to effect any significant changes in his students' attitudes and knowledge of computer and computer-assisted instruction? This study has investigated two strategies for teaching about the computer without the availability of a computer system for his students. I was unable to find any previous research that has made such an attempt.

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# CHAPTER III

## DESCRIPTION OF POPULATION

The elementary school pre-service teachers who participated in this study were enrolled in the course Education 325 F, Teaching Science in the Elementary School, at Michigan State University during winter term, 1970. This is a three credit course open to juniors and is normally taken simultaneously with other professional methods courses. The other methods courses are: Curriculum--Methods and Materials in Elementary Education, Methods of Teaching Reading in the Elementary School, Teaching Language Arts in the Elementary Grades, and Teaching Mathematics in the Elementary Grades. The 1970 Michigan State University catalogue describes this science methods course as follows:

> Extends the science background of prospective elementary teachers. Emphasis is placed upon methods and materials for science in the elementary classroom. (1)

The course consisted of ten one-hour lectures and nine two-hour laboratory sessions. (See Appendix A for course outline.) The students were given their computer instruction during these two-hour laboratory sessions.

The participants were, as in most elementary teacher training programs, more than ninety per cent female, with most participants in the nineteen to twenty-two age category, and several participants over forty-five years of age.

The students' total program for that term was arranged with no formal classes scheduled on Thursdays. This "free" day was used to observe directly children in a classroom situation. These students would visit a neighboring school once each week and often assist the teacher in various activities.

In previous terms, these participating students were required to take the following science and mathematics courses: Math 201--Foundations of Arithmetic, Biological Science 202--Foundations of Biological Science, and Physical Science 203--Foundations of Physical Science. Also, those students who had chosen either science or mathematics as a major or minor area of concentration were required to take a full year of Natural Science as well as electives in a wide variety of science areas. No formal computer science course is required of these students, nor had any of the participants taken any formal training in computers or computer programming. Following this course, the students would engage in ten weeks of a student teaching experience.

The original sample of pre-service elementary school teachers consisted of 245 subjects. However, due to improper procedures in completing their evaluation forms, or absences in one or more phases of the treatment, only 223 subjects were used in the analysis of data.

The pre-service secondary school teachers who participated in this study were enrolled in the course Education 327 S at Michigan State University in the winter term of 1970, and spring term 1971. This is a five credit course entitled "Methods of Teaching Secondary Science." The course description taken from the 1970 Michigan State University Catalogue states:

> Specifics of classroom instruction in the various subject matter fields. Selection of presentation and evaluation techniques based on recognized course objectives. (2)

The course consisted of one three-hour session per week during the winter term. A "Free School" was also associated with the course. The "Free School" was designed to give the participants of this methods course first-hand experiences with middle school children. Prior to the formal class meeting, a group of volunteer children would come to the university and engage in science activities as provided by the students and instructor of this secondary methods course. (See Appendix B for course outline.)

This course is open to upperclassmen and is usually taken in the junior year. The participants have a wide variety of backgrounds in both science and mathematics as this course is required of all who plan to teach at the secondary level, regardless of science subject major. The class was about evenly split between males and females in both the winter term and spring term enrollments with most members falling into the nineteen to twenty-one year age range. The course was very similar spring term with the classroom sessions being split into two one and a half hour sessions rather than one three-hour session. A "Free School" similar to the one in the winter term was also conducted during spring term. (See Appendix C for course outline.)

## Method of Treatment

The elementary level of this study consisted of twelve classrooms enrolled in the elementary science methods course during winter term 1970 at Michigan State University. These classrooms were randomly assigned to one of three treatment groups. This randomization was accomplished by numbering the groups from one to twelve. Once each classroom was assigned a number, these numbers were then written upon one side of a blank three by five inch index card. The cards were shuffled thoroughly. Three containers were labeled to indicate which treatment they represented. The shuffled deck of index cards was then dealt into these containers until each container held four cards. Thus, each classroom was assigned to a particular treatment.

Using a table of random numbers, all students in the secondary science methods course, Education 327 S of winter term, 1970, were assigned to either of two treatment groups. The control group for the pre-service secondary school teachers was taken from a similar 327 S methods class for the spring term of 1971. Two weeks into the spring term, or about one month after treatment had been administered to the other secondary methods groups, the evaluative instruments were administered to the entire class of the secondary science methods class of spring term, 1971. None of the class activities to that point had involved any discussion of computers or computer related topics and the assumption is made that this group is randomly equivalent to both the groups that received the computer lessons, and therefore would be a valid control group for the secondary level.

Toward the middle of the term, each class was exposed to its assigned treatment for one hour each week for two consecutive weeks, followed by an evaluation in the third week. No treatment group was informed that there would be any type of evaluation given regarding these computer lessons. When the evaluation instruments were being administered, the groups were assured that their scores on these measures were totally independent of their grades or evaluation in the methods course.

The elementary methods' classrooms assigned to treatment one served as the control group; that is, they were not exposed to any discussion or lessons regarding computers or computer related topics. During the first week of treatment, these classrooms were engaged in an activity entitled, "Attribute Games and Problems" (3), an activity developed by Educational Development Center for its elementary science program. The authors of this program describe the objectives of this unit as follows:

> Attribute Games and Problems is concerned with the development of thinking skills of children. It provides an opportunity for children to deal with problems involving classification and the relationships between classes. (4)

The particular activities performed by these control groups were "A Blocks," "People Pieces," "Color Cubes," and "Creature Cards." Using the problem cards provided as guides, the students engaged in these activities to familiarize themselves with the elementary science program.

The second week's activity involved the use of a unit taken from an elementary science curriculum program called "Science Curriculum Improvement Study" (SCIS). The activity used was entitled "The Whirly Bird System." (5)

It is part of a larger unit called "Systems and Subsystems" and is used normally in a third grade classroom. The objectives of this unit, as stated by its authors, are:

> To identify functional subsystems of a simple mechanical system.
>
> To contribute data for the construction of a histogram.
>
> To identify variables that may affect the outcome of an experiment with a simple mechanical system.
>
> To determine the effect of changing one variable on a simple mechanical system. (6)

The Whirly Bird system itself is a wooden mechanical system consisting of a wooden base and crosspiece which comprise the support subsystem, an elastic band, which serves as a starter subsystem, and a wooden dowel, spool, and arm which together serve as a spinning subsystem. These functional subsystems are all connected with the appropriate hardware. The subjects were asked to identify the subsystems and identify those variables that would affect the length of time the spinning system of Whirly Bird would stay in motion. They were also required to manipulate the variables so that their Whirly Bird would continue spinning as long as possible.

The activities chosen for the elementary level control groups were selected for their compatibility with the objectives of this elementary method while having no apparent affect on the subjects' knowledge or attitudes toward computers.

Treatment Two (see Appendix D) consisted of two one-hour computer lessons using "Cardiac" as the main instructional tool. The objectives of these lessons were:

1. To familiarize the students with the basic components of a computer system.
2. To familiarize the students with basic terms relating to computers and computer-assisted instruction.
3. To acquaint the students with the concepts of computer programs and computer programming.

The students each received a "Cardiac" and a "Cardiac" manual. The first segment of the session was spent assembling the "Cardiac" device. The instructor then led a discussion as to the specific steps involved in the solution of a simple addition problem. A flowchart was then constructed adhering to the standard flowchart symbols. Numbers, number systems, and symbols were discussed and a simple program for "Cardiac" was developed to add two numbers together. As this program developed, different types of programming languages were discussed. The basic components of computer systems were also introduced and information flow through part of the computer system was diagrammed.

The second hour of instruction consisted of the execution of the previously developed program for "Cardiac." This instruction introduced the use of the control unit and compiler of a computer system. A more complex program was developed which demonstrated how a computer system might multiply by repeated addition. This final session was concluded by a discussion of the attributes of computers that make them appropriate for aids to the teacher. This format was used both with the elementary and secondary pre-service school teachers.

Treatment Three (see Appendix E) consisted of two one-hour computer lessons using a variety of visual aids as the main instrumental tools. The objectives of these computer lessons were identical to the objectives of the previously described treatment.

During the first one-hour session, several film loops were shown along with 35 mm slides and overhead projection slides. Using these aids, the basic components of a computer system were discussed and illustrated with particular emphasis on number systems and symbol systems. A series of slides were used which demonstrated how a computer problem is prepared for the computer system and this problem is followed as far as the input devices of the computer system. The second hour of the computer lessons mapped the flow of the problem through the computer system until it is returned as one type of output. Various output devices were shown with the advantages of each being discussed. Slides and line drawings were used primarily to illustrate the sequence of events that occurred. This session was also concluded by a discussion of the attributes of computers that make them appropriate aids for the classroom teacher.

## Instrumentation

### Knowledge of Computers

The instrument used in this study to measure the subjects' knowledge of computers was constructed by the writer as an evaluation of the objectives of the lessons presented on computers. It was first administered to a teacher workshop group at Michigan State University in the summer of 1970. An item analysis was completed and the test revised. The second edition of this cognitive measure was examined by five professional computer consultants from the Data Management Service Corporation, a computer consulting firm in Philadelphia, Pa. Their suggestions and modifications were incorporated into the test instrument which was given to a pilot group of 325F students in the fall term, 1970, at Michigan State University.

To further validate these test items, the final edition of this examination was administered to the Computer Science 322 class at Michigan State University, spring term, 1971. Computer Science 322--Introduction to Theory of Computing--is a high level undergraduate course at Michigan State University. Prerequisites for this course are: Computer Science 120--Computer Programming, Computer Science 300--Computer Programming, Computer Science 311--Machine and Assembly Languages, Computer Science 312--Compilers and Interpreters, Computer Science 313--Introduction to Systems Programming, and Computer Science 321--Introduction to Discrete Structures. This examination was administered to these students toward the end of the term during a regular classroom session by their professor. A one-way analysis of variance was then run between these experts and the control groups, who were assumed to be representative of all subjects in this study, before treatments were administered. The summary of this analysis is found in Table 1.

Table 1. Analysis of variance between computer science students' and pre-service teachers' scores on a measure of computer knowledge.

| Source of Variance | Sum of Squares | Df | Mean Squares | F |
|---|---|---|---|---|
| Between Categories | 863.85 | 1 | 863.85 | 141.42* |
| Within Categories | 702.46 | 115 | 6.11 | --- |

*Significant at the .0005 level.

The mean score for the teacher group was 7.76 while the mean score for the computer science group was approximately double that, 15.47. The pre-service teachers' scores ranged from 3 to 17 while the range of scores of the computer science group was from 13 to 18.

The analysis of these data plainly show that the computer "experts" do significantly better on this instrument than the pre-service elementary and secondary teachers used in this study. The computer science group had a much narrower range of scores, with their lowest score being five points more than the mean score of the teacher group. These data seem to lend additional support to the validity of this measure for it does show that the information contained in this measure is well known by those who have been working with computers.

The reliability of this instrument was calculated using the FORTAP computer program (7) for the Control Data Corporation 3600 computer system at Michigan State University. This computer program will calculate the Hoyt Reliability coefficient (8) through an analysis of variance technique. The reliability coefficient for this measure was calculated to be .5781. The summary statistics for the analysis of these data are found in Table 2.

A final item analysis was run using the data collected from the subjects of this study (see Appendix F for copy of instrument). Table 3 contains a summary of this item analysis (see Appendix G for complete item analysis).

Table 2. Hoyt reliability coefficient for measure of computer knowledge.

| Source of Variance | Df | Sum of Squares | Mean Square | F |
|---|---|---|---|---|
| Individuals | 282 | 140.52 | 49.83 | 2.35 |
| Items | 19 | 132.48 | 6.97 | 32.83 |
| Error | 5358 | 1137.92 | .21 | |
| Total | 5659 | 1410.92 | | |

Mean Score = 9.46 Standard Deviation = 3.1569

Table 3. Summary data of item analysis of measure of computer knowledge.

| | Distribution of Item Difficulty Indices | | Distribution of Discrimination Indices | |
|---|---|---|---|---|
| | Number of Items | Percentage | Number of Items | Percentage |
| 91-100 | 0 | 0 | 0 | 0 |
| 81-90 | 0 | 0 | 0 | 0 |
| 71-80 | 2 | 10 | 0 | 0 |
| 61-70 | 2 | 10 | 0 | 0 |
| 51-60 | 8 | 40 | 3 | 15 |
| 41-50 | 3 | 15 | 7 | 35 |
| 31-40 | 3 | 15 | 5 | 25 |
| 21-30 | 2 | 10 | 5 | 25 |
| 11-20 | 0 | 0 | 0 | 0 |
| 00-10 | 0 | 0 | 0 | 0 |

Mean Item Difficulty = 52

Mean Item Discrimination = 38

Standard Error = 2.0793

Attitude Toward Computers

I constructed the semantic differential used in this study to measure attitude toward computers (see Appendix H). This form of attitude measure, as described by Osgood and Suci (9) has had widespread use. In order to use this technique for the measurement of attitudes, the authors state:

> . . .to index attitude, we must use sets of scales which have high loadings on the evaluative factors across concepts generally and negative loading in other factors. (10)

A set of twenty highly evaluative bi-polar adjective pairs were drawn from several studies that have used this technique in the measurement of attitude. The studies of Melnick, Wahlert, and Yukor (11) and Steinman (12) were particularly helpful since these researchers used this technique to measure the attitudes their subjects had toward the specific concept--computer. I was also able to identify those adjective pairs which seemed to have high discrimination in their particular studies.

The semantic differential was administered to a pilot group of in-service teachers during a workshop held in the summer of 1970 at Michigan State University. Several revisions were made and the revised edition of this measure was again administered to a pilot group of elementary method students and secondary method students during fall term of 1970. Few changes were deemed necessary after this pilot study, and the measure was given as revised to all subjects in this study.

Osgood and Suci (13) have conducted an in-depth analysis of the semantic differential establishing the face validity of this procedure. After repeated administration of this procedure over a wide variety of situations, they have concluded:

> Throughout our work with the semantic differential we have had no reasons to question the validity of the technique on the basis of its correspondence with results to be expected from common sense. (14)

These researchers are also able to demonstrate high correlation of the semantic differential with other external criteria. (15)

The reliability of this measure was analyzed from data collected from all subjects who participated in the study. The FORTAP (16) computer program was again used to calculate the Hoyt Coefficient of Reliability. (17) The reliability of this instrument as used in this study was calculated to be .8980. The summary statistics for the analysis of these data are found in Table 4.

### Attitude Toward Computer-Assisted Instruction

The instrument used to evaluate the subjects' attitude toward computer-assisted instruction (see Appendix I) was developed by C. Robardy (18) for use in his

Table 4. Hoyt reliability coefficient for measure of attitude toward computers.

| Source of Variance | Df | Sum of Squares | Mean Square | F |
|---|---|---|---|---|
| Individuals | 282 | 2080.58 | 7.39 | 9.81 |
| Items | 19 | 150.36 | 7.91 | 10.52 |
| Error | 5358 | 4030.24 | .75 | |
| Total | 5659 | 6261.18 | | |
| Mean Score = 77.73 | | Standard Deviation = 12.15 | | |

dissertation presently being completed at Michigan State University. Robardy is presently employed by the Department of Education for the State of Michigan in the Computer-Assisted Instruction division.

The face validity of each item was rated by a team of experts. (19) They assigned a value of from zero to four; a zero indicating no apparent validity, while a rating of four would indicate a very high face validity. Table 5 indicates the mean face validity for each item.

The overall face validity of this instrument, .750, is a reasonably high and acceptable figure for this instrument.

To establish the construct validity of this measure, a variation of the known-groups technique was employed. By administering this scale to two groups, whose attitudes toward computer-assisted instruction are known to differ,

Table 5. Mean face validity for items on measure of attitude toward computer-assisted instruction.

| Item | Mean Face Validity | Item | Mean Face Validity |
|---|---|---|---|
| 1 | .500 | 11 | .667 |
| 2 | .750 | 12 | .917 |
| 3 | .917 | 13 | .750 |
| 4 | .583 | 14 | .583 |
| 5 | .883 | 15 | .917 |
| 6 | .883 | 16 | .667 |
| 7 | .750 | 17 | .667 |
| 8 | .583 | 18 | .667 |
| 9 | .500 | 19 | .667 |
| 10 | .583 | 20 | .750 |
| Overall Face Validity = .750 | | | |

Robardy analyzed the resulting data using a "t" test as described by Hays (20) for unequal variances and sample sizes. He was able to reject the null hypothesis that there would be no significant differences in the mean scores of the two known group means. Table 6 shows a summary of these statistics.

The reliability of this instrument was calculated using the FORTAP (21) computer program for the Control Data Corporation 3600 computer system. This program

Table 6. Summary of construct validity statistics for measure of attitude toward computer-assisted instruction.

| | |
|---|---|
| Estimated Standard Deviation | 2.76 |
| Corrected Number of Degrees of Freedom | 58.00 |
| Computed "t" Statistic | 3.84* |

*Significant at the .001 level.

calculates the Hoyt (22) reliability coefficient. Table 7 shows the summary statistics for this analysis from data collected from all subjects participating in this study. The reliability of this instrument as used in this study was calculated to be .8986.

Table 7. Hoyt reliability coefficient for measure of attitude toward computer-assisted instruction.

| Source of Variance | Df | Sum of Squares | Mean Square | F |
|---|---|---|---|---|
| Individuals | 282 | 1836.38 | 6.51 | 9.87 |
| Items | 19 | 180.75 | 9.51 | 14.41 |
| Error | 5338 | 3536.45 | .66 | |
| Total | 5659 | 5553.58 | | |

Mean Score = 61.75 Standard Deviation = 11.41

## Hypotheses Tested

The following multivariate null hypotheses and associated univariate null hypotheses were tested in this study:

1. There is no significant difference in scores of pre-service elementary school teachers and pre-service secondary school teachers over all three measures.

The univariate null hypotheses associated with this multivariate hypothesis that were tested are:

a. There is no significant difference in the knowledge of computers between pre-service elementary school teachers and pre-service secondary school teachers.

b. There is no significant difference in attitude toward computers between pre-service elementary school teachers and pre-service secondary school teachers.

c. There is no significant difference in attitude toward computer-assisted instruction between pre-service elementary school teachers and pre-service secondary school teachers.

2. There is no significant difference between the control group, the cardiac group, and the multi-media group as determined by their scores over all three measures.

The univariate null hypotheses associated with this multivariate hypothesis that were tested are:

a. There is no significant difference in knowledge of computers between the control group, the cardiac group, and the multi-media group.

b. There is no significant difference in attitude toward computers between the control group, the cardiac group, and the multi-media group.

c. There is no significant difference in attitude toward computer-assisted instruction between the control group, the cardiac group, and the multi-media group.

3. There will be no significant interaction between levels, (elementary or secondary) and treatments (control, cardiac, or multi-media) over all three measures.

The univariate null hypotheses associated with this multivariate hypothesis that were tested are:

a. There will be no significant interaction between levels and treatments in knowledge of computers.

b. There will be no significant interaction between levels and treatments in attitude toward computers.

c. There will be no significant interaction between levels and treatments in attitude toward computer-assisted instruction.

## Assumptions and Analysis Models

The data obtained from this study were analyzed using a multivariate analysis of variance. This analysis was performed using the Finn (23) computer program for the Control Data Corporation 3600 computer system at Michigan State University. The writer decided to analyze the data of this study using two different models. The first statistical model analyzes the data using the elementary school classroom as the experimental unit. A diagram of this design is found in Figure 1.

### Assumptions for Analysis of Variance

1. The residuals are normally and independently distributed with zero means and the same variance. (24)

Although there is no reason to suspect this assumption, Box and Anderson state that the F test on the analysis of variance is remarkably insensitive to general non-normality. (25)

2. The variance of each of the design groups should be homogeneous. (26)

There is no reason to assume that there is a violation of this assumption. Also, however, when

| | | $M_1$ | $M_2$ | $M_3$ |
|---|---|---|---|---|
| $T_1$ | $C_1$ $C_2$ $C_3$ $C_4$ | | | |
| $T_2$ | $C_5$ $C_6$ $C_7$ $C_8$ | | | |
| $T_3$ | $C_9$ $C_{10}$ $C_{11}$ $C_{12}$ | | | |

Figure 1. Multivariate one-way analysis of variance elementary classrooms.

Legend: $T_1$ = Control Group

$T_2$ = Cardiac Group

$T_3$ = Multi-Media Group

$M_1$ = Knowledge of Computers Instrument

$M_2$ = Attitude Toward Computers Instrument

$M_3$ = Attitude Toward Computer-Assisted Instruction Instrument

$C_1$ through $C_{12}$ = Classrooms one through twelve there is no great disparity between group sizes, the F statistic is robust to a violation of this assumption.

3. The experimental units comprising each of the design groups should be independent. (27)

This assumption is interpreted for this study to infer specifically:

a. independence among groups and levels

b. independence between treatments

c. independence between levels

The same data, along with the data from the secondary pre-service school teachers were reanalyzed using a second statistical model. Here a two-way multivariate analysis of variance was used with the assumption that the individual is a valid experimental unit. Figure 2 depicts this second model used.

The assumptions of the two-way multivariate analysis of variance are identical with those described above. This model, however, assumes that learning about computers, attitude toward computers, and attitudes toward computer-assisted instruction are learned as an individual. The differences caused by being in one particular classroom or another are assumed to be trivial in this study since both the treatments and instructor were identical for any particular treatment group. These two analyses are presented

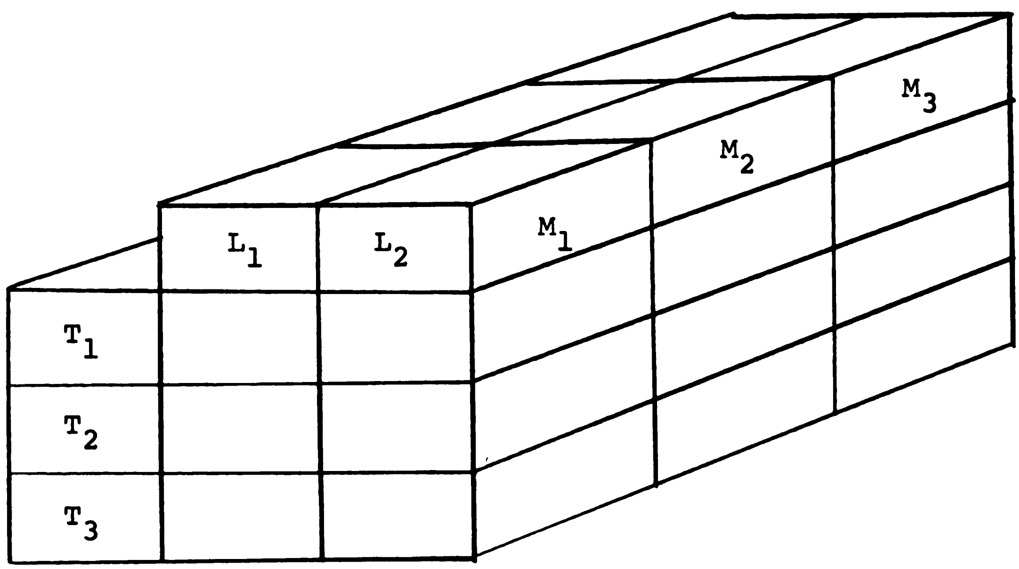


Figure 2. Two-way multivariate analysis of variance elementary and secondary pre-service teachers.

Legend: $T_1$ = Control Group

$T_2$ = Cardiac Group

$T_3$ = Multi-Media Group

$M_1$ = Knowledge of Computers Instrument

$M_2$ = Attitude Toward Computers Instrument

$M_3$ = Attitude Toward Computer-Assisted Instruction Instrument

$L_1$ = Elementary Pre-Service School Teachers

$L_2$ = Secondary Pre-Service School Teachers to afford the reader as much information as possible regarding this study.

## Summary

The subjects of this study were pre-service elementary teachers taken from the elementary science methods classes at Michigan State University, winter term, 1970 and pre-service secondary teachers taken from the secondary science methods classes at Michigan State University winter term, 1970, and spring term, 1971.

Three different treatments were performed on the subjects of this study. $T_1$ was designated as the control group which engaged in activities unrelated to computers. $T_2$ was designated as the "cardiac" group who were instructed about computer using cardiac as the main instructional tool. $T_3$ was designated as the "multi-media" group who were instructed about computers using a wide variety of media as the principal method of instruction.

Three measures were used to assess the knowledge of computers, attitude toward computers, or attitudes toward computer-assisted instruction of the subjects in the three treatment groups. Reliability studies and validity studies were piloted and completed on these three instruments.

The data were analyzed using two models: model one was a one-way multivariate analysis of variance which assumed the elementary classroom as the experimental unit. Model two was a two-way analysis of variance using the individual as the experimental unit.

The hypotheses were tested, and the analysis of data is found in the following chapter.

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CHAPTER IV

INTRODUCTION

The data collected by the procedures described in Chapter Three are presented in this chapter. As previously noted, the data for the elementary pre-service school teacher have been analyzed using two different statistical models. Post-hoc comparisons have been performed where additional meaningful information could be obtained. A .05 level of significance was selected for acceptance or rejection.

## Analysis of Data

### Model One

The multivariate null hypothesis tested in this first statistical model was:

The mean scores for the elementary classrooms in the control group, the cardiac group, and the multi-media group would not significantly differ over all three measures.

Symbolically: Ho: $m_1 = m_2 = m_3$ over all three measures.

The associated univariate null hypotheses also tested were:

The mean scores for the elementary classrooms in the control group, the cardiac group, and the multi-media group would not significantly differ in:

1. knowledge of computers ($M_1$)
2. attitude toward computers ($M_2$)
3. attitude toward computer-assisted instruction ($M_3$)

A one-way analysis of variance was conducted using the Finn (1) computer program for the Control Data 3600 computer system at Michigan State University. The results of the analysis of these data follow.

Table 8. Table of means for each treatment group for each measure.

| Treatment Group | Knowledge of Computers | Attitude toward Computers | Attitude toward CAI |
|---|---|---|---|
| Control | 7.475 | 73.225 | 61.925 |
| Cardiac | 9.800 | 76.575 | 61.825 |
| Multi-Media | 9.850 | 78.475 | 61.475 |
| Pooled Standard Deviation | .2893 | 2.640 | 1.421 |

The data from Table 8 shows a gain in knowledge of computers by both the cardiac group and the multi-media group. Although the multi-media group scores were slightly higher than the cardiac groups', the difference in these scores represents half a question and, as will be shown in Table 10, has little meaning. Both treatments seemed to have had an equal effect upon the subjects' knowledge of computers. The cardiac group and the multi-media group also show a gain in attitude toward computers as measured by the semantic differential, with the multi-media group scoring almost two points more than the cardiac group. Here again both treatments seemed to have caused some positive movements in attitude toward computers.

Neither treatment seemed to have had any effect on the subjects' attitude toward computer-assisted instruction, however. This was somewhat unexpected in light of their gain in knowledge and more positive attitude toward computers. Yet as one studies Table 8, there is no meaningful difference in any of the scores on the measure that evaluates the subjects' attitudes toward computer-assisted instruction.

The correlation matrix as illustrated in Table 9 reveals several interesting relationships. The correlation between attitude toward computers and knowledge of computers is quite high at .694. As each class learned

Table 9. Correlation matrix for three measures for elementary pre-service school teachers.

| | Knowledge of Computers | Attitude toward Computers | Attitude toward CAI |
|---|---|---|---|
| Knowledge of Computers | 1.000000 | | |
| Attitude toward Computers | 0.694114 | 1.000000 | |
| Attitude toward CAI | -0.423918 | -0.06906 | 1.000000 |

more about computers, it also acquired a more positive attitude toward computers. But a more favorable attitude toward computers does not necessarily connote a more favorable attitude toward computer-assisted instruction as shown by this correlation coefficient of -0.06906. Most surprising is the negative correlation between knowledge of computers and attitude toward computer-assisted instruction. This correlation of -0.423918 seems to indicate that as each class learned more about the computer, it tended to feel somewhat more negatively toward it as a classroom aid.

The F ratio for the multivariate test for equality of the mean vectors was equal to 2.5936 with six and fourteen degrees of freedom. This F ratio generates a p less than .0665. Since we had set as our criteria of significance a p less than .05 (the probability of this difference being a chance happening) for a two-tailed test, we are unable to reject the multivariate null hypotheses for elementary classrooms.

Table 10 summarizes the findings for each of the associated univariated hypotheses that also were tested.

Table 10. Summary of univariate hypotheses for pre-service elementary classrooms.

| Variable | Between Mean Square | Univariate F | p less than |
|---|---|---|---|
| Knowledge of Computers | 7.3658 | 9.3140 | 0.0065 |
| Attitude toward Computers | 28.2633 | 4.0490 | 0.0557 |
| Attitude toward CAI | .2233 | 0.1105 | 0.8966 |

Although the multivariate null hypothesis was not rejected at the .05 level, Table 10 does show a difference in means in both the knowledge of computer measure (p less than .0065) and attitude toward computer measure (p less than .0557). This again indicates that the treatments did have some effect upon the knowledge of computers and the attitude toward computers of the participating classroom.

## Model Two

A second analysis of the data from this study was performed, using the pre-service elementary school teacher and the pre-service secondary school teacher as the experimental unit. Tables 11, 12, and 13 show the means for each treatment group and each level for each measure.

Table 11. Table of means for each treatment group and level for measure one--knowledge of computers.

| Treatment Group | Elementary | Secondary |
|---|---|---|
| Control | 7.475 | 8.900 |
| Cardiac | 10.083 | 11.882 |
| Multi-Media | 9.853 | 12.220 |

Pooled Standard Deviation = 2.8196.

Table 11 does demonstrate that secondary pre-service school teachers tend to have more computer knowledge in their background. This may well be due to stronger formal training in mathematics. Also, several of the participants at the secondary school level had had some dealings with computers in one manner or another. It is interesting to note, however, that both elementary and secondary school pre-service teachers do gain approximately equally with both treatments. This would seem to suggest that even though the secondary school subjects did begin the treatments with a somewhat higher baseline level of knowledge of computers, the treatments were sophisticated enough to be beneficial to both groups.

A two-way multivariate analysis of variance was performed to determine if there is a significant level main effect. The multivariate null hypothesis tested was:

Do elementary pre-service school teachers and secondary pre-service school teachers significantly differ over all three measures.

Symbolically: Ho: $m_1 = m_2$

The associated univariate null hypotheses tested were:

Do pre-service elementary and secondary school teachers differ significantly in:

1. knowledge of computers
2. attitude toward computers
3. attitude toward computer-assisted instruction.

The analysis of these data produced an F ratio of 9.0019 with three and 272 degrees of freedom. This F ratio generates a p of less than .0001. Therefore, the multivariate hypothesis combining all three measures is rejected. Over all three measures then, pre-service elementary and pre-service secondary school teachers do differ. Table 12 summarizes the findings of the univariate null hypotheses tests.

Table 12. Summary of univariate hypotheses for pre-service elementary and secondary school teachers.

| Variable | Between Mean Square | Univariate F | p less than |
|---|---|---|---|
| Knowledge of Computers | 163.5434 | 20.5713 | .0001 |
| Attitude toward Computers | 528.9828 | 5.3519 | .0215 |
| Attitude toward CAI | 32.4516 | 2.0067 | .1578 |

Table 12 shows the reader that the differences in means between the elementary pre-service school teacher and the secondary pre-service school teacher scores of the measure of knowledge of computers seen in Table 11 are significant at the .0001 level. The attitudes that these teachers have towards computers is also significantly different with a level of significance of less than .0215. Table 13 shows the mean scores of the elementary and secondary subjects on the measure of attitude toward computers.

It can also be seen that though the two levels, elementary and secondary, do significantly differ on both knowledge and attitude toward computers, they do not significantly differ in their attitudes toward computer-assisted instruction. As noted earlier, there seems to be a distinct difference in the minds of the participants between the computer as a device that can do calculations extremely rapidly and accurately, and the computer as an aid in instruction. As one peruses the six cells of Table 14 which summarizes the mean scores for both levels and the three groups, it is quite obvious that the measure of attitude toward computer-assisted instruction was not able to demonstrate any meaningful differences between any of the six cells. The homogeneity of these scores is apparent.

Table 13. Table of means for each treatment group and level for measure two--attitude toward computers.

| Treatment Group | Elementary | Secondary |
|---|---|---|
| Control | 73.400 | 78.100 |
| Cardiac | 76.833 | 82.353 |
| Multi-Media | 78.568 | 79.200 |

Pooled Standard Deviation = 9.9478.

Table 14. Table of means for each treatment group and level for measure three--attitude toward CAI.

| Treatment Group | Elementary | Secondary |
|---|---|---|
| Control | 61.962 | 63.050 |
| Cardiac | 61.333 | 62.393 |
| Multi-Media | 61.537 | 62.050 |

Pooled Standard Deviation = 4.0214.

In order to measure the effectiveness of the different computer treatments, a second multivariate null hypothesis was tested. This hypothesis was:

The control group, the cardiac group, and the multi-media group will not significantly differ over all three measures.

Symbolically: $m_1 = m_2 = m_3$

The associated null univariate hypotheses also tested were:

The control group, the cardiac group, and the multi-media group will not differ significantly in their

1. knowledge of computers
2. attitude toward computers
3. attitude toward computer-assisted instruction.

The computations of the data to test the multivariate null hypothesis revealed an F-ratio of 9.6813 with six and 544 degrees of freedom. This F-ratio generates a p value of less than .0001. Therefore the multivariate null hypothesis was rejected. There was a significant difference at the .0001 level of confidence among the three treatment groups over all three measures.

Table 15 summarizes the results of the three univariate hypotheses computations.

From Table 15, the reader can see that the treatment groups did differ significantly both in their knowledge of computers, p less than .0001, and in their

Table 15. Summary of univariate hypotheses for three treatment groups.

| Variable | Between Mean Square | Univariate F | p less than |
|---|---|---|---|
| Knowledge of Computers | 216.9925 | 27.2944 | 0.0001 |
| Attitude toward Computers | 570.3007 | 5.7700 | 0.0036 |
| Attitude toward CAI | 10.5831 | 0.6544 | 0.5206 |

attitude toward computers, p less than .0036. No significant difference was found between these treatment groups' attitude toward computer-assisted instruction, however. In light of the treatment group means as shown in Table 14, it was quite obvious that neither of the computer treatments was able to effect any significant change in the subjects' attitude toward computer-assisted instruction.

To answer the question of there being a significant difference between treatments, and which treatment was most effective, post-hoc comparisons were conducted. In regard to knowledge of computers, the mean score for the control group was 7.760, the mean score for the cardiac group was 10.553, and the mean score for the multi-media group was 10.261. Only one post-hoc comparison would reveal any meaningful information, testing to find if there was a significant difference between the cardiac or multi-media group, and the control group. A "t" test was performed to find if there was a significant difference between the multi-media group and the control group. The multi-media group was chosen for this comparison since its mean was slightly lower than the cardiac groups, and if its mean was significantly different from the control groups, then we can be sure that there was also a significant difference between the cardiac group and the control group. Using the formula

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{Sp^2 \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

the "t" statistic for this post-hoc comparison was 6.4876. This value is significant at the .05 level. Therefore, both the cardiac computer lessons and the multi-media computer lessons were able to cause a gain in the subjects' knowledge of computers. Also, both treatments seemed equally effective for elementary and secondary school pre-service teachers.

A second post-hoc comparison was performed to detect how the specific treatment groups affected the subjects' attitude toward computers. On the measure of attitude toward computers, the control groups mean was 74.340, the cardiac group mean was 78.276, and the multi-media groups' mean was 78.677. Here also it can be seen that the cardiac group mean and the multi-media group mean are basically the same. Using the same rationale as was used with the previous post-hoc comparison a "t" test was performed using the mean score of the control group and the cardiac group. The "t" value obtained from this analysis was 2.485 which is significant at the .05 level. Both the cardiac computer lessons and the multi-media computer lessons then, were able to cause a gain in the attitude of the participants toward computers. Again, both of these treatment methods seemed to work equally well with both levels of treatment.

The third multivariate hypothesis tested was to find if any interaction existed between treatments and levels, that is, did any of the treatments work differently for one level or the other?

The multivariate null hypothesis tested was:

The mean scores for each treatment group, (control, cardiac, or multi-media) would not significantly differ for each level (elementary or secondary).

Symbolically: Ho: $m_1 = m_2 = m_3 = m_4 = m_5 = m_6$

The associated univariate hypotheses tested were:

Each treatment group would not significantly differ for each level in their

1. knowledge of computers
2. attitude toward computers

3. attitude toward computer-assisted instruction.

The computations for these data, in testing the multivariate null hypothesis, generated an F-ratio of 0.6024 with six and 544 degrees of freedom. This F-ratio is associated with a p of less than .7286. Since our criteria for significance was the 0.05 level, we are unable to reject the null hypothesis that there was no treatment-level interaction. We assume then, that the treatments worked equally with either level.

Table 16 summarizes the results of the testing of the associated univariate hypotheses.

Table 16. Summary of univariate hypotheses for treatment-level interaction.

| Variable | Between Mean Square | Univariate F | p less than |
|---|---|---|---|
| Knowledge of Computers | 3.4981 | 0.4400 | 0.6445 |
| Attitude toward Computers | 105.0022 | 1.0623 | 0.3471 |
| Attitude toward CAI | 1.5676 | 0.0969 | 0.9077 |

Table 16 clearly indicates that there is no significant treatment-level interaction in any of the facets of the pre-service teacher-computer relationships we have examined in this study. These results demonstrate that the effectiveness of the treatment does not alter from one level to the other for any of the three measures used in this study.

A correlation matrix is presented in Table 17 to display the various correlations between the three variables examined in this study. Although there were some fairly high correlations exhibited, both positive and negative, when the elementary classrooms were examined, these seemed to have "washed out" when the individual was examined as the experimental unit. As one scrutinizes the correlation matrix, it is apparent that there is no clear relationship between any of the variables. A high score on one measure, then, in no way would indicate a high score on any of the other measures, or knowing an individual's attitude toward computers would not tell us anything about his attitude toward computer-assisted instruction or his knowledge of computers.

Table 17. Correlation matrix for three measures for elementary and secondary pre-service school teachers.

| | Knowledge of Computers | Attitude toward Computers | Attitude toward CAI |
|---|---|---|---|
| Knowledge of Computers | 1.000000 | | |
| Attitude toward Computers | 0.115032 | 1.000000 | |
| Attitude toward CAI | -0.045638 | -0.116167 | 1.000000 |

Using the Profile Program (2), a special analysis was conducted on the measure of attitude toward computers in order to determine what aspects of the subjects' attitude toward computers differed between the three treatment groups. The mean score for each group was determined for each item. An analysis of variance was performed on the data to determine if there was a group by item interaction. No clear-cut interaction was obtained. Therefore, no post-hoc comparisons were done on individual items. However, this analysis did provide valuable insight into the effect each of the various treatments had on particular aspects of the subjects' attitudes toward computers. Table 18 illustrates the mean score for each pre-service elementary school teacher group for each item while Figure 3 is a graphic presentation of this information.

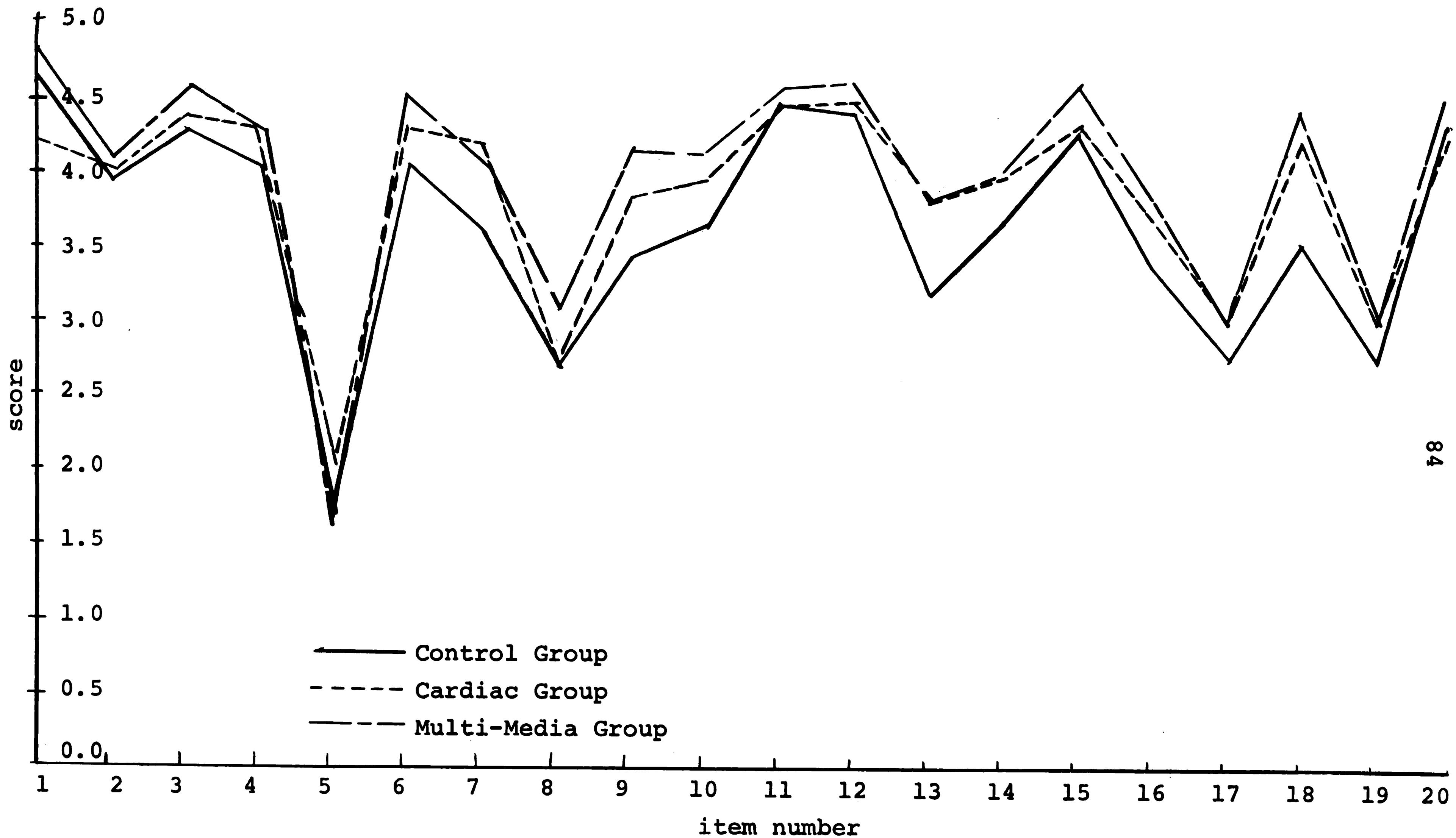
Figure 3 demonstrates that, in practically every item, both the cardiac group and the multi-media group have a more positive feeling than the control group. The largest difference appears in item thirteen, approachable-unapproachable. Both treatments seemed to have made the computer appear more approachable to the subjects. All three treatment groups scored quite low on item five, simple-complex. Evidently neither treatment was able to cause the participants to perceive the computer as being anything but complex. Both computer treatments caused their participants to score higher on item ten,

Table 18. Profile of pre-service elementary school teachers' attitude toward computers.

| Item Number | Adjective Pair | Control | Cardiac | Multi-Media |
|---|---|---|---|---|
| 1 | Slow-Fast | 4.650 | 4.250 | 4.589 |
| 2 | Strong-Weak | 3.975 | 4.042 | 4.095 |
| 3 | Worthwile-Worthless | 4.275 | 4.396 | 4.568 |
| 4 | Good-Bad | 4.037 | 4.292 | 4.305 |
| 5 | Simple-Complex | 1.825 | 2.021 | 1.663 |
| 6 | Harmful-Beneficial | 4.000 | 4.271 | 4.474 |
| 7 | Safe-Dangerous | 3.600 | 4.188 | 4.053 |
| 8 | Flexible-Rigid | 2.700 | 2.708 | 3.053 |
| 9 | Necessary-Unnecessary | 3.938 | 3.833 | 4.116 |
| 10 | Like-Dislike | 3.563 | 3.917 | 4.105 |
| 11 | Efficient-Inefficient | 4.425 | 4.396 | 4.537 |
| 12 | Useful-Useless | 4.350 | 4.458 | 4.568 |
| 13 | Approachable-Unapproachable | 3.188 | 3.750 | 3.768 |
| 14 | Boring-Interesting | 3.650 | 3.950 | 3.916 |
| 15 | Accurate-Inaccurate | 4.237 | 4.292 | 4.537 |
| 16 | Understandable-Incomprehensible | 3.313 | 3.688 | 3.579 |
| 17 | Easy to Use-Hard to Use | 2.737 | 3.021 | 2.905 |
| 18 | Productive-Destructive | 3.987 | 4.146 | 4.387 |
| 19 | Fallible-Infallible | 2.712 | 2.979 | 2.905 |
| 20 | Important-Unimportant | 4.237 | 4.229 | 4.442 |

like-dislike, with the multi-media group being somewhat higher on this item than the cardiac group. In general, however, the control group scored quite high on this

Figure 3. Profile of pre-service elementary school teachers' attitude toward computers.


score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Control Group
Cardiac Group
Multi-Media Group
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
item number

attitude measure in light of the fact that they have had no exposure to computers. They certainly did not have a negative feeling toward this machine, as illustrated by the fact that their scores were greater than 3.5 on such items as like-dislike, beneficial-harmful, interesting-boring, useful-useless, and good-bad, all evaluative factors of this attitude scale.

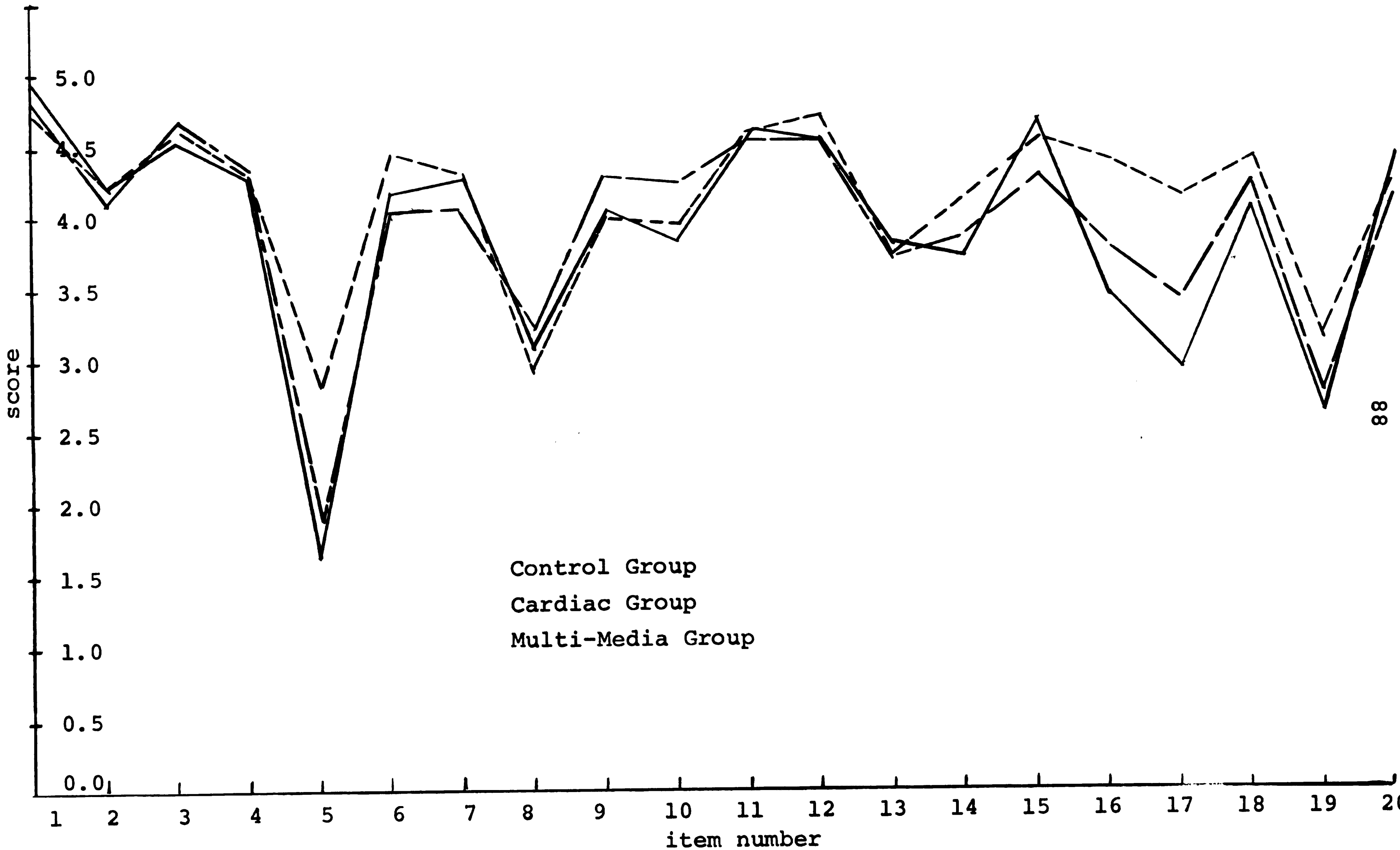
Table 19 is a profile of the secondary school pre-service teachers' attitude toward computers and Figure 4 is the graph of that Table.

The attitude toward computers of the three treatment groups is much less spread for the secondary pre-service school teacher group than it was for the three treatment groups of elementary pre-service school teachers. The one outstanding feature of Figure 4 is the difference in the mean scores of the three treatment groups on item sixteen, understandable-incomprehensible, and item seventeen, easy to use-hard to use. The cardiac group scored much higher on these two items than either the control group or the multi-media group. This may well indicate that the use of the teaching device "cardiac" was very helpful in causing those participants to understand the workings of a computer and as such caused them to feel as though the computer would be easier to use than they had thought originally. Referring back to Table 13, the mean score on this measure of attitude toward computers for

Table 19. Profile of pre-service secondary school teachers' attitude toward computers.

| Item Number | Adjective Pair | Control | Cardiac | Multi-Media |
|---|---|---|---|---|
| 1 | Slow-Fast | 4.900 | 4.706 | 4.750 |
| 2 | Strong-Weak | 4.200 | 4.235 | 4.100 |
| 3 | Worthwhile-Worthless | 4.500 | 4.588 | 5.650 |
| 4 | Good-Bad | 4.250 | 4.294 | 4.300 |
| 5 | Simple-Complex | 1.650 | 2.824 | 1.900 |
| 6 | Harmful-Beneficial | 4.150 | 4.412 | 4.050 |
| 7 | Safe-Dangerous | 4.250 | 4.294 | 4.050 |
| 8 | Flexible-Rigid | 3.100 | 2.941 | 3.200 |
| 9 | Necessary-Unnecessary | 4.050 | 3.941 | 4.300 |
| 10 | Like-Dislike | 3.850 | 3.941 | 4.250 |
| 11 | Efficient-Inefficient | 4.600 | 4.588 | 4.550 |
| 12 | Useful-Useless | 4.550 | 4.706 | 4.550 |
| 13 | Approachable-Unapproachable | 3.850 | 3.765 | 3.750 |
| 14 | Boring-Interesting | 3.750 | 4.118 | 3.900 |
| 15 | Accurate-Inaccurate | 4.700 | 4.529 | 4.350 |
| 16 | Understandable-Incomprehensible | 3.500 | 4.412 | 3.850 |
| 17 | Easy to Use-Hard to Use | 3.000 | 4.118 | 3.450 |
| 18 | Productive-Destructive | 4.100 | 4.471 | 4.250 |
| 19 | Fallible-Infallible | 2.700 | 3.118 | 2.800 |
| 20 | Important-Unimportant | 4.450 | 4.353 | 4.280 |

Figure 4. Profile of pre-service secondary school teachers' attitude toward computers.


score
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
item number
Control Group
Cardiac Group
Multi-Media Group

the secondary control group was 78.100 for the secondary cardiac group, 82.355 and for the secondary multi-media group, 79.220, it could well be that these two items were the major factors in the cardiac group's higher scores. Figure 4 also seems to give this indication.

## Summary of Study's Findings

### Elementary-Secondary

This study indicates that secondary pre-service school teachers tend to know more about computers before any treatment than elementary pre-service school teachers. Yet they do benefit equally from either the cardiac computer lessons or the multi-media computer lessons. This benefit is displayed in their gain in knowledge and also in their more positive attitude toward computers. In particular, the secondary school group seemed to indicate that the cardiac lessons made the computers more understandable and easier to use. The attitude toward computer-assisted instruction seemed unaffected by any treatment. This finding seems to point up a distinct difference in the minds of the participants between the concept of computers and their perception of computer-assisted instruction.

Cardiac-Multi-Media

This study was unable to demonstrate that one of these computer treatments was more effective than the other, with either the elementary or secondary group. Each was equally effective with both levels in increasing knowledge and leading to a more positive attitude toward computers, but both were equally ineffective in changing attitude toward computer-assisted instruction. Tables 18 and 19 do indicate which facets of the attitude toward computers were differentially affected by a particular treatment. The important finding is, however, that the material presented by either of the methods was accepted and learned by the students, not only as incidental knowledge, but also was internalized enough to cause a significant change in their attitude toward computers.

Knowledge of Computers

As mentioned earlier, the secondary group of pre-service school teachers did possess greater knowledge of computers than the elementary group. Yet both scored somewhat low on the twenty item knowledge measure, the mean score for the elementary control group being 7.475 while the mean score for the secondary group was 8.900. There appeared to be no resistance to learning about computers as all groups were quite receptive. The teaching environment was not always ideal, for the room used was small and without proper ventilation. When the slide projector, overhead projector, and film loop projector were being employed, the room did become somewhat stuffy. Yet the students seemed to be attentive and genuinely interested. Both elementary and secondary school students showed significant gains in knowledge despite the brevity of the treatments.

## Attitude toward Computers

Contrary to the findings of some researchers, these pre-service teachers did not display negative attitudes toward the machine--computer. If a score of sixty is considered to be completely neutral for this measure, then it can be seen that the control groups' scores of 73.4 and 78.1 do show a positive attitude toward the computer by both levels, although the secondary group scores are consistently higher than the elementarys' (see Table 13). Both treatments caused significant gains in that groups' attitude toward computers, with the multimedia lessons seeming to be more effective for the elementary group; the cardiac treatment seemed to be more effective for the secondary groups.

## Attitude toward Computer-Assisted Instruction

Here again, if we consider a score of sixty as indicating complete neutrality on the measure of attitude toward computer-assisted instruction, as the reader scans Table 14 he can see that the scores do indicate very neutral feelings toward computer-assisted instruction. Also, neither treatment was able to alter this neutrality for either level. In light of the subjects' positive attitudes toward computers, this neutrality toward computer-assisted instruction does signal some anxiety toward the use of the computer as an instructional aid. Learning about the hardware and software of a computer system did not seem to alleviate this apparent fear.

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# CHAPTER V

# CONCLUSIONS AND IMPLICATIONS

The purpose of this study was to investigate and analyze the effect on both pre-service elementary and pre-service secondary school teachers, of two teaching strategies upon their knowledge of computers, their attitude toward computers, and their attitude toward computer-assisted instruction.

## Conclusions

It has been shown that using either the Bell Telephone science teaching device "cardiac," or using a multi-media approach to introduce computers, does cause a significant increase in knowledge in pre-service elementary and secondary school teachers. It has also been shown that either of these two teaching strategies effected a positive change in the participants' attitude toward computers. Neither of the procedures used, however, was able to cause any alteration in the subjects' attitude toward computer-assisted instruction.

It has also been shown that, before treatment, secondary pre-service teachers had greater knowledge of computers and also a more positive attitude toward computers. Yet, both teaching strategies used in this study were not significantly different for the elementary and secondary teacher groups.

Although both teaching techniques caused significant gains in knowledge of computers and more positive attitude toward computers, neither technique was more effective than the other. There is no evidence in this study that would support choosing one of these two teaching strategies as being preferable over the other.

When the data from the elementary pre-service teachers were analyzed using the classroom as the experimental unit, there was a fairly high positive correlation between knowledge of computers and attitude toward computers, implying that as one gained knowledge of computers, he also tended to have a more positive attitude toward them. A negative correlation also appeared between knowledge of computers and attitude toward computer-assisted instruction, implying that as one learned more about computers, he tended to think less highly of computer-assisted instruction. When the same data were analyzed using the individual as the experimental unit, no clear-cut correlations could be seen between any of the variables.

An in-depth analysis of the measure of attitude toward computers revealed that in most aspects of this attitude measure, both the cardiac and the multi-media group tended to have more positive scores than the control group. These discrepancies were much less obvious in the secondary teachers' group than in the elementary teachers' group. The cardiac treatment group of secondary teachers did seem to feel they had a greater understanding of computers and after treatment felt it was easier to use.

## Implications

The findings of this study indicate that, when presented at the appropriate level and in a meaningful manner, the basic facts regarding computer hardware and software are well within the grasp of the pre-service teacher. There is no negative attitude toward the computer as a machine, and after even a brief exposure as demonstrated in this study, there was a significant gain in attitude toward computers. The implications are, that of any of the six recommendations of the Commission on Instructional Technology (1) in its report "To Improve Learning," it is essential that teacher education institutions begin immediate basic innovations to provide their pre-service teachers with not only a basic knowledge of the new educational technologies, but also a positive disposition toward them. I believe this study has shown that this is feasible with relatively little effort.

This study has also shown that learning about a machine only is not enough for the classroom teacher. It must be demonstrated to him that this machine, whether it be a computer or another piece of equipment, can be an integral part of his teaching paraphernalia, and that it can make a substantial contribution to the quality of learning in that classroom.

This study was unable to demonstrate any ability to alter the neutral feelings that the participants had toward computer-assisted instruction. It did point out that learning about computers and even thinking more positively toward computers is not a dramatic enough experience to carry with it a positive attitude toward computer-assisted instruction. A "hands-on" experience seems essential, not one that teaches how to use a computer but one that teaches how to use it in the classroom.

If school systems could have free access to computer systems tomorrow, what would be the result? Would most administrators be prepared? Department heads? Classroom teachers? Aside from preparing schedules and perhaps bus routes, what would most school systems do with this resource? The major implication of the findings of this study seem to be that the pre-service teacher, either elementary or secondary, is receptive and able to learn about computers. This fact, combined with the continuing search for ways to improve the quality of education, implores teacher education institutions to alter their curricula to provide their students with the opportunity to learn about and use the computer, not to have it solve a problem for finding the volume of an irregularly shaped object, but to have the computer help pinpoint a particular student's weaknesses, or produce an item analysis of an examination.

> The vast majority of the members of the teaching profession have accepted the fact (or in some cases simply become resigned to it) that education must leave the era of "hand labor" and turn to machines to help increase their productivity. That we must turn to the using of power tools in education to allow teachers to become more effective is a fact accepted to the teaching profession today, albeit with varying degrees of pleasure and readiness. (2)

Teacher's Colleges and Universities are just now making the slightest movement toward instilling this "readiness" in prospective teachers. Still, the area of computer education for the teacher is practically non-existent.

## Implications for Further Research

A replication of this study with an additional treatment group, one which would have an actual access to a computer system, would point out which aspects of the three variables used in this study would still be significantly affected without the expense of a computer system, and which of the variables are most affected by a "hands-on" experience.

An investigation into a teacher's perception of a computer as opposed to his perception of computer-assisted instruction would help clarify the apparent disparity in these two concepts as revealed by this study. Also, the lack of any correlation between the variables could well justify an in-depth investigation.

Further research into these same areas using other personality instruments and attitude inventories might reveal further insights into which are the major factors that have contributed to the findings of this study.

A comparison of pre-service teachers and experienced teachers in the field, I believe, would also disclose some important factors in helping design a training program for the education curriculum of a teacher education institution.

A replication of this study with a greater period of time devoted to each treatment would help indicate the optimum time to devote to any particular aspect of the study. Also, a follow-up questionnaire would help indicate if these treatments had a short term effect only, or if they did have a lasting effect, particularly upon attitudes.

A replication of this study using secondary pre-service teachers from the entering freshman class would help compensate for the fact that the pre-service secondary school teachers in a science methods class are some type of science specialist while the pre-service elementary school teachers in the elementary science methods classes have had no special training in science or math. This procedure would make the elementary and secondary groups more equivalent.

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(2) *Ibid*., 55.

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# APPENDIX A

## COURSE OUTLINE FOR EDUCATION 325F WINTER, 1971

## TEACHING ELEMENTARY SCHOOL SCIENCE

ED 325F
Teaching Elementary School Science
Winter, 1971

INSTRUCTORS

Dr. B. Cheney
359 Erickson Hall
353-0695

Mr. Dell Mueller
301d Erickson Hall
353-3796

Dr. C. Vogan
115 Erickson Hall
353-6451

Mr. Sid Fagan
E 25 McDonel Hall
355-1725

Office Hours - Dr. Cheney

Tuesday 8:30 - 10:00
Others by Appointment

Wednesday 1:30 - 3:00
Others by Appointment

Text: Anderson, Devito, Dyrli, Kellogg, Kochendorfer, Wiegand. Developing Children's Thinking Through Science. Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1970, 370 pp.

Class Meeting Schedule

Lecture Session - McDonel Kiva - Friday 10:20 - 11:10

Demonstration - Discussion - Laboratory Sessions

| | | |
|---|---|---|
| Monday | 8:00 - 10:00 | 101 McDonel |
| | 3:00 - 5:00 | 101 McDonel |
| Tuesday | 3:00 - 5:00 | 101 McDonel |
| Wednesday | 8:00 - 10:00 | 101 McDonel |
| | 7:00 - 9:00 p.m. | 101 McDonel |
| Friday | 12:40 - 2:40 | 101 McDonel |

McDonel Kiva Meetings
Ed 325F: Elementary School Science Teaching
Winter, 1971-Cheney

Jan. 8 1.0 Science in the elementary school curriculum
- 1.1 Why should it be included?
- 1.2 How has it been justified at different periods in our history?
- 1.3 How may it benefit the child and the teacher?

Read Chapter 1

Jan. 15 2.0 Viewpoints on how children learn ... (science)
- 2.1 What kinds of thinking are children able to do?
  - 2.11 Piaget
  - 2.12 Bruner
  - 2.13 Gagné
- 2.2 What are the implications of these viewpoints for teaching science?

Read Chapter 5

Jan. 22 3.0 A "process" program in science education
- 3.1 Science - A Process Approach - AAAS
  - 3.11 The "basic processes"
  - 3.12 The "integrated processes"
  - 3.13 Task analysis and a learning hierarchy
  - 3.14 A "process" demonstration

Read Chapter 7

Jan. 29 4.0 A Criterion-referenced learning program in science.
- 4.1 What are the characteristics of such a program?
  - 4.11 Psychological basis
  - 4.12 Performance objectives
  - 4.13 Clusters of related modules
  - 4.14 Individualized instruction
  - 4.15 Evaluation of pupil achievement
  - 4.16 AAAS, Science-A Process Approach as a model

Read Chapter 2

Feb. 5 5.0 The conceptually organized science program
- 5.1 Characteristics of a conceptually organized program
  - 5.11 Psychological and educational rationale

5.12 Sources of subject-matter
5.13 Evaluation of pupil achievement
5.14 Science Curriculum Improvement Study (SCIS) as a model

Read Chapter 6

Feb. 12 6.0 Teaching science in the "open classroom"
6.1 Characteristics of an "open classroom"
6.11 Psychological basis
6.12 Responsive environment concept
6.13 Individualized instruction
6.14 Evaluation of pupil achievement
6.15 Elementary Science Study (ESS) as a model

Read Chapter 4

Feb. 19 7.0 1960's science programs for the 1970's
7.1 Do the conditions in which Science revisions were made in the 60's still prevail as we enter the 70's?
7.11 The demand for accountability in education
7.12 National assessment of pupil achievement
7.13 Experience with science curriculum revisions.
7.14 Environmental education
7.15 Health education

Read Chapter 10

Feb. 26 8.0 Film Program
8.1 Scenes from classrooms
8.2 Science Teaching exemplars

Read Chapter 11

March 5 9.0 Characteristics of an effective classroom program in science.
9.1 What are the time commitments for Science?
9.2 Materials for teaching science
9.3 To use or not to use a science textbook
9.4 The relationship of science to other subjects
9.41 Reading
9.42 Mathematics
9.43 Social Studies
9.44 Language Arts
9.45 Art and Music

Read Chapter 8

| | | |
|---|---|---|
| March 12 | 10.0 | Getting started as a science teacher |
| | | 10.1 Concern for variety in teaching procedures |
| | | 10.2 Capitalizing on pupil interests--incidental teaching |
| | | 10.3 Congruence of your teaching philosophy and your teaching practices |
| | | 10.4 Developing an independent learner |
| | | Read Chapter 9 |

Final Exam - Tue., March 16, 12:45 - 1:45 p.m.

(Math exam 1:45 - 2:45)

APPENDIX C

COURSE OUTLINE FOR EDUCATION 327S SPRING, 1971

TEACHING SECONDARY SCHOOL SCIENCE

TEXT

1. The Improvement of Biology Teaching
   Joseph D. Novak

2. Readings in Science Education
   Hans Anderson

ASSIGNMENTS

New Curricula Presentation

The class will be divided into four or more groups. Each group will investigate one of the curricular areas (general science, biology, chemistry, physics) and prepare a 20 minute panel presentation on the new curricula for the rest of the class.

The presentation should include:

1. Major emphasis of the course--topics, objectives, content, etc.

2. Major laboratory experiences in the course.

3. Teacher aids available, including audio-visual.

4. Evaluation instruments available.

This presentation will be graded on the completeness of the treatment, the quality of the handouts prepared for the class, and the facility with which the presentation is made. All members will receive a composite grade based on overall quality of the group work and on his individual presentation.

Assignment due Tuesday, April 13.

METHOD OF DETERMINING GRADES

Your grade will be based on classroom contributions, hand-in work, and test scores.

Classroom Contributions
- class attendance
- class discussion
- demonstration lessons
- assigned presentations
- evidence that you have met above objectives
- optional responsibilities

2) Chapters 1, 2, pp. 3-63.

Paper Due--Lesson plan for Free School Experience.

Each individual will present a 10 minute demonstration lesson. This lesson will be accompanied by a one-page lesson plan that is on a ditto master and includes:

1. The objectives of the lesson.
2. Motivational activity.
3. Learning activities or procedure of the demonstration.
4. Sketch of the demonstration apparatus.
5. List of materials used.
6. Summary activities.

The presentation will be graded on:

1. Evidence of careful planning and preparation.
2. Appropriateness of the demonstration for stated objectives,
3. Skill and facility with which the presentation is made.

March 1 — Computers and Secondary Science Instruction. Demonstration Lessons by Individuals (Groups A-D; E-H)

2) Chapters 4, 5, pp. 64-124.

March 8 — Computer and Secondary Science Instruction. Feedback Systems and Evaluation. Course Summary.

Paper Due--Present four test items. They should test application of knowledge. Two should be essay and the other two objective.

March 15 — FINAL EXAMINATION, 8:00 - 10:00 P.M.

3.0 OBJECTIVES OF THE COURSE

3.1 To acquaint future secondary teachers with the concepts of modern science education, the processes of inquiry in the sciences, and the methods whereby these can be effectively taught in the secondary school.

3.2 To describe the nature of science in such a way that it is consistent with science education literature.

3.3 To classify teaching episodes as to their probable effectiveness in teaching attitudes, concepts, and processes and to justify their classification system.

3.4 To derive objectives of science education from the nature of science and the psychology of learning.

3.5 As a result of course experiences, the student should be able to:

--identify major components of the newer secondary science curricula.
--describe conventional secondary science curricula and compare them with the newer curricula.
--list and describe the science processes.
--demonstrate detailed knowledge of the newer curricula in at least one area (General Science, Biology, Chemistry, or Physics).
--identify divergent and convergent questions and state their proper use in teaching secondary school science.
--contrast and compare the contributions that Jerome Bruner, Robert Gagne, and Jean Piaget have made to modern science curricula.
--demonstrate proper teaching techniques through demonstration lessons.
--describe an acceptable laboratory organization for secondary school science.

4.0 METHOD OF DETERMINING GRADES

Your grade will be based on classroom contributions, hand-in work, and test scores.

4.1 Classroom contributions
--class attendance.
--class discussion.
--demonstration lessons.
--assigned presentations.
--evidence that you have met above objectives.
--optional responsibilities.

4.2 Hand-in Work
--paper on new curricula
--comparison of scientific supply houses.
--lesson plans for Free School experiences.
--lesson plan for demonstration lessons.
--four test items.

## 4.3 Tests

--MID-TERM
--FINAL

INSTRUCTOR: Glenn D. Berkheimer E-37 McDonel Hall 355-1725

Hand-in Work

paper on new curricula
comparison of scientific supply houses
lesson plans for free school experiences
lesson plan for demonstration lessons
four test items

Tests

Midterm
Final

Instructor: Martin Hetherington E 37 McDonel Hall 355-1725

Spring, 1971

TEACHING SECONDARY SCHOOL SCIENCE

Dr. Martin Hetherington

| | | |
|---|---|---|
| Thursday | April 1 | What is Science?<br>Group Assigned for New Curricula Presentations. |
| Tuesday | April 6 | Science and Science Education<br>Techniques of Teaching the Laboratory |
| Thursday | April 8 | The Role of the Teacher<br>Asking Good Questions - Question Types |
| Tuesday | April 13 | New Curricula Presentations |
| Thursday | April 15 | Introduction of Whirly Bird |
| Tuesday | April 20 | Free School Preparation and the First Free School Session |
| Thursday | April 22 | Review of Free School Experience<br>Evaluation of Laboratory Experiences<br>Micro-teaching |
| Tuesday | April 27 | The Goals of Science Education<br>Second Free School Session<br>Whirly Bird or Rolling Spheres |
| Thursday | April 29 | Psychology of Learning<br>Piaget and Gagné<br>Science Curriculum Reform |
| Tuesday | May 4 | Lesson Planning<br>Third Free School Session |
| Thursday | May 6 | Midterm |
| Tuesday | May 11 | Classroom Management<br>Individual, Small Group, Large Group, Team Teaching<br>Fourth Free School Session<br>Option Selected by Teacher and Student |
| Thursday | May 13 | Techniques of Teaching the Demonstration |

| | | |
|---|---|---|
| Tuesday | May 18 | Fifth Free School Session<br>Demonstrations |
| Thursday | May 20 | Problems and Trends in Evaluation<br>Goals and Behavioral Objectives |
| Tuesday | May 25 | What is a Good Science Test<br>Types of Test Questions |
| Thursday | May 27 | Computers and Secondary Science<br>Instruction |
| Tuesday | June 1 | Feedback Systems and Evaluation<br>Course Summary |
| Thursday | June 3 | Final Examination |

Spring, 1971

TEACHING SECONDARY SCHOOL SCIENCE

Dr. Martin Hetherington

Readings from the two texts that are available for this course:

<u>Readings in Science Education for the Secondary School</u>
Hans O. Andersen

<u>The Improvement of Biology Teaching</u>
Joseph D. Novak

| | | |
|---|---|---|
| Thursday April 1 | Andersen<br>Novak | pp. 1-43<br>pp. 1-30 |
| Tuesday April 6 | Andersen | pp. 97-113, 114-123, 233-235 |
| Thursday | Andersen<br><br>Novak | pp. 48-49, 60-69, 86-96, 181-191, 192-198, 198-204<br>pp. 31-38, 52-53 |
| Tuesday | Andersen<br><br>Novak | pp. 205-207, 207-214, 245-252, 252-257, 257-261, 261-266<br>pp. 75-82<br>Appendix A 135-172 (information for first paper if you are working on BSCS) |
| Thursday | Novak | Appendix B 173-183 and 90-91 (Information for second paper)<br>pp. 75-85, 184-188 |
| Tuesday April 20 | Andersen | pp. 266-270, 270-275 |
| Thursday April 22 | Andersen<br>Novak | pp. 169-174<br>pp. 82-84 |
| Tuesday April 27 | Andersen | pp. 123-131, 131-139 |
| Thursday April 29 | Andersen<br>Novak | pp. 276-348<br>pp. 55-73 |
| Tuesday May 4 | Andersen | pp. 223-226<br>pp. 55-73 |
| Thursday May 6 | | Midterm |

| | | |
|---|---|---|
| Tuesday May 11 | Andersen | pp. 70-79, 80-83, 145-149, 214-218, 219-223 |
| | Novak | pp. 48-52, 85-87 |
| Thursday May 13 | Andersen | pp. 237-241, 242-244 |
| | Novak | pp. 39-48 |
| Tuesday May 18 | Novak | pp. 189-190 |
| Thursday May 20 | Andersen | pp. 45-47, 142-145, 149-152, 152-153, 153-157 |
| | Novak | pp. 44-48, 92-97 |
| Tuesday May 25 | Andersen | pp. 157-165, 165-169 |
| Thursday May 27 | Andersen | pp. 349-431 |
| Tuesday June 1 | Andersen | pp. 174-178 |
| Thursday June 3 | | Final Exam |

# APPENDIX D

## TREATMENT TWO--CARDIAC

## TREATMENT TWO--CARDIAC

Objectives:

1. To familiarize the students with the basic components of a computer system.
2. To familiarize the students with basic terms dealing with computers and computer-assisted instruction.
3. To acquaint students with the concepts of a computer program and computer programming.

### Lesson One

### Outline of Activities

I. Distribute Cardiac, Cardiac Manual, and cellophane tape

II. Construct Cardiac (See Figure 5)

III. Introduce symbolic language of Cardiac

   A. Three digit number

      1. First digit operational code

      2. Last two digits memory cell locations

   B. Introduce some operational codes and their abbreviations

      1. 0 INP Input or Read

      2. 1 CLA Clear accumulator and add

      3. 2 ADD Add to accumulator

      4. 5 OUT Print on output card

      5. 6 STO Store in Memory

      6. 9 HRS Halt program and reset counter

   C. Other symbolic languages include FORTRAN And COBOL

IV. Writing a Program

   A. Define problem-have cardiac simulate a computer adding two numbers "A" and "B".

   B. Construct Flowchart

Figure 5

## Cardiac
## ASSEMBLY INSTRUCTIONS

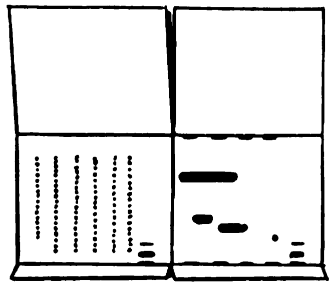


Fig. 1

1. Remove all parts from the die cut sheet. The 5 "bugs" and the 4 input/output cards won't be needed for the assembly and should be set aside for now. Incidentally, 4 of the bugs are spares, as are 2 of the input/output cards.

2. Punch out all the die cut holes--including the 100 circular holes in the memory section. Be sure to punch out <u>all</u> 5 windows on the "Op Code" slide.

3. Fold CARDIAC along the 3 score marks. Run your finger over the folds to make sure they "take."

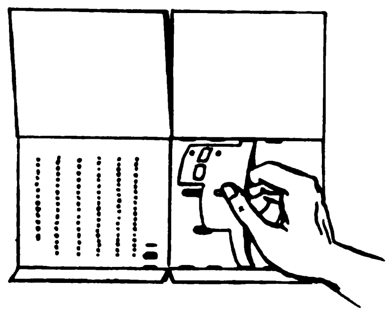


Fig. 2

4. Unfold CARDIAC and lay it face down (blank side up) on a clean surface (see Fig. 1). The windows and slots should be on the lower right page. Notice the 4 sets of slots cut into the top and bottom edges of this page. These will accommodate the 4 function slides, which are to be inserted (printed sides down) in the following order:

   A. Slip the "Op Code" slide into the 3rd pair of slots (top and bottom) from the left (see Fig. 2). <u>This slide must be inserted first</u>.

   B. Slip the "Address (2)" slide into the 2nd pair of slots from the left.

   C. Slip the "Address (1)" slide into the 1st pair of slots from the left.

   D. Slip the "Accumulator Test" slide into the 4th pair of slots from the left.

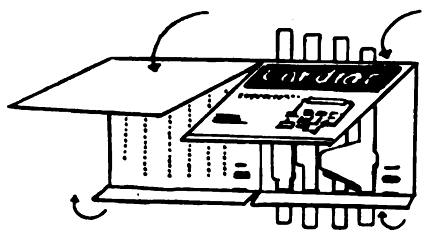


Fig. 3

5. Fold the top half of CARDIAC down over the bottom half. Check the slides for free movement and correct position (see Fig. 3). If everything is in order, run a thin bead of glue along the full length of the bottom edge of CARDIAC. Repeat this assembly on left-hand side (back of CARDIAC and memory cells). <u>Be careful not to get any glue on the slides or the slots</u>. Now, fold up the bottom edge and hold, or weight, it until the glue dries. Your CARDIAC should now look like Fig. 4.

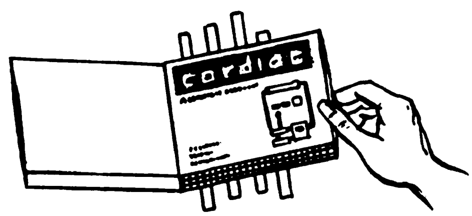
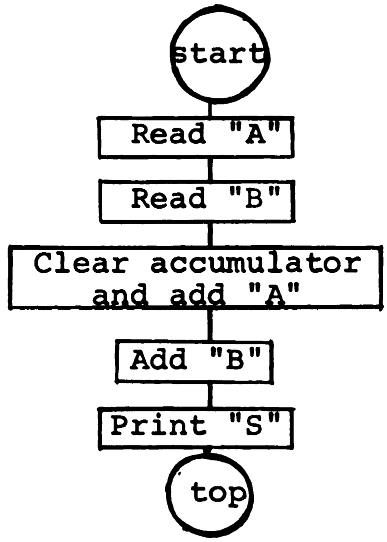



Fig. 4




C. Program steps outlined by flowchart for Cardiac

1. Program ADD

| Symbolic Language | Result |
|---|---|
| 034 | "A" is stored in memory cell 34 |
| 035 | "B" is stored in memory cell 35 |
| 134 | Accumulator is cleared and "A" is added to accumulator |
| 235 | "B" is added to accumulator giving sum "S" |
| 636 | "S" is stored in memory cell 36 |
| 536 | Contents of memory cell 36 printed on output card. |
| 900 | Program halted and program counter reset |

V. Discuss various output devices

A. Magnetic Tape

B. Punch Cards

C. Punched Paper Tape

D. Cathode Ray Tube

VI. Discuss various input devices

A. Magnetic Tape

B. Punch Cards

C. Punched Paper Tape

D. Keyboard

VII. Discuss function of accumulator (Central Processing Unit-CPU)

Lesson Two

I. Execute Program Add

A. Start

B. Move slides to agree with content of the bug's cell (034).

C. Move bug ahead one cell.

D. Accumulator Test - Is input card blank?

E. Instruction decoder--student performs task as outlined by instruction decoder.

F. Move slides to agree with contents of the bug's cell.

G. Continue in this manner until program is halted.

II. Discuss function of "bug" (Program counter)

III. Discuss function of control Unit

A. Advance program counter

B. Fetch instruction from memory

C. Execute instruction in instruction register

D. Discuss function of Compiler and Assembler

IV. Introduce concept of subroutines

V. Program Multiplication

A. Develop flowchart (see Figure 6)

B. Develop symbolic program

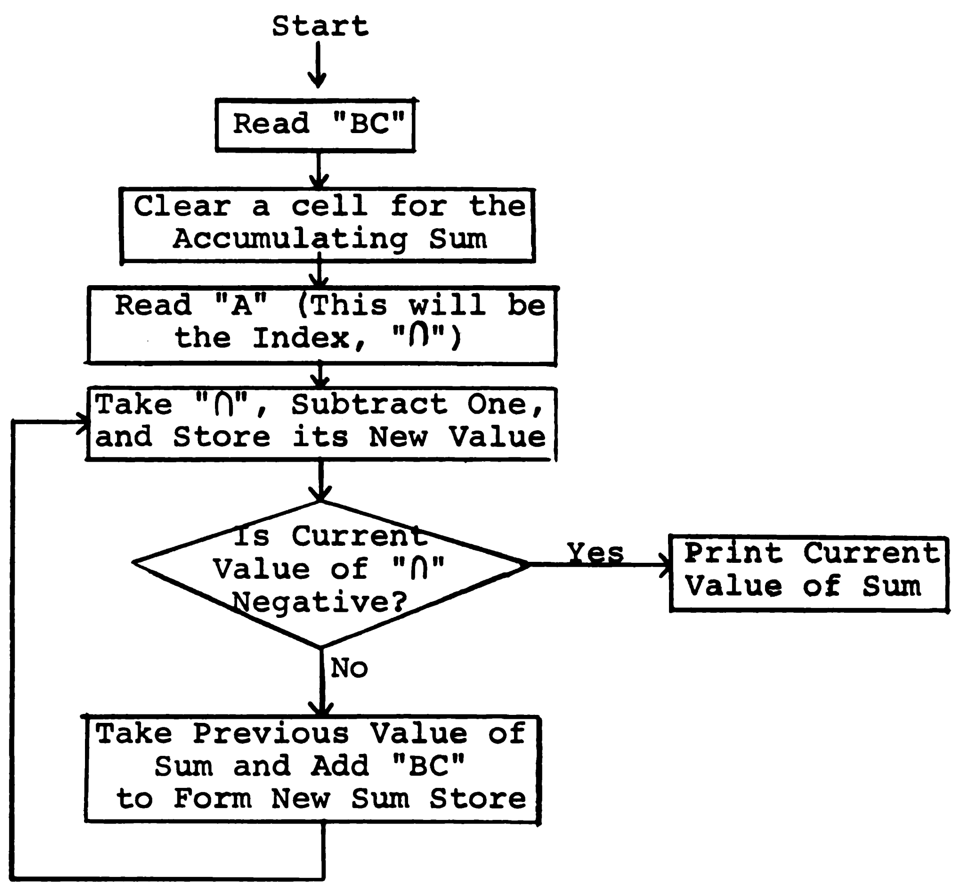
1. 068 Read two digit number "BC" into cell 68

2. 404 Clear accumulator

3. 669 Store accumulator in cell 69

Figure 6

Flow chart of single-digit multiplication




4. 070 Read "A" into cell 70. This will be "n."

5. 170 "n" to accumulator.

6. 700 subtract 1 from "n."

7. 670 Store revised "n."

8. 319 Test accumulator sign.

9. 169 Clear accumulator. Enter contents of cell 69 (previous sum).

10. 268 Add "BC" to accumulator.

11. 669 Store revised sum in cell 69.

12. 811 Jump back to cell 11.

13. 569 Print (product of "A" x "BC").

C. Execute Program Mult

VI. Discuss looping (operational code 8) and getting out of a loop (operational code 3).

VII. Discuss computer systems overall.

VIII. Discuss computers in education.

APPENDIX E

TREATMENT THREE

A MULTI-MEDIA APPROACH

TREATMENT THREE

A MULTI-MEDIA APPROACH

Objectives:

1. To familiarize the students with the basic components of a computer system.

2. To familiarize the students with basic terms dealing with computers and computer-assisted instruction.

3. To acquaint students with the concepts of a computer program and computer programming.

## Lesson One

## Outline of Activities

Visuals (S = 35mm slide, OH = Overhead projection, FL = 8mm film loop, Demo = type of demonstration)

| Sequence | Visual Type | Explanation |
|---|---|---|
| 1. | OH | Block diagram of computer problem preparation |
| 2. | S | Student in class receiving problem |
| 3. | S | Student coding problem into FORTRAN |
| 4. | FL | Film Loop showing preparation of flowchart |
| 5. | S | Student going into Computer Center |
| 6. | S | Keypunch Machine |
| 7. | OH | Line drawing of keypunch machine |
| 8. | S | Close-up of keyboard of keypunch machine |
| 9. | OH | Line drawing of keyboard of keypunch machine |
| 10. | OH | Line drawing of IBM Punch Card |
| 11. | Demo | Display of Binary System |
| 12. | FL | Film Loop demonstrating Binary Number System |
| 13. | OH | Various Binary Devices |
| 14. | S | Student using keypunch machine |

| | | |
|---|---|---|
| 15. | S | Close-up of hands of student using keypunch machine |
| 16. | S | Student submitting program deck to input clerk |
| 17. | Demo | Show program deck |
| 18. | S | Student receiving receipt stub from input clerk |
| 19. | S | Program deck is filed |
| 20. | OH | Block diagram of computer system |
| 21. | S | Operator places program decks in card reading machine |
| 22. | S | Close-up picture of card reading machine |
| 23. | S | Different view of card reading machine |
| 24. | S | Operator removing cards from card reading machine |
| 25. | OH | Line Drawing of card reading device |
| 26. | S | Memory Unit |
| 27. | OH | Line Drawing of Memory Unit |
| 28. | FL | Film Loop of various memory devices |
| 29. | S | Many memory circuits |
| 30. | S | Picture of doughnut shaped memory device |
| 31. | S | Slide of picture taken from Life Magazine of memory core |
| 32. | OH | Drawing of doughnut shaped memory device and dime for size comparison |
| 33. | OH | Block diagram of computer system |

| | | |
|---|---|---|
| 34. | S | Control Unit |
| 35. | S | Tape Libraries |

<u>Lesson Two</u>

| | | |
|---|---|---|
| 36. | OH | Block diagram of computer system |
| 37. | S | Accumulator (Central Processing Unit) |
| 38. | S | Monroe Calculator (as an analogy) |
| 39. | S | Circuit boards of computer system |
| 40. | S | Close-up of circuit boards |
| 41. | S | Close-up of transistors and resistors of circuit board |
| 42. | S | Compass and magnet |
| 43. | S | Magnet with current flowing |
| 44. | S | Latest circuits, postage stamp size |
| 45. | S | Wiring of computers |
| 46. | S | Wiring of computers |
| 47. | FL | Information Processing |
| 48. | S | Magnetic Tape as output |
| 49. | S | Tape Drive Machine |
| 50. | S | Line Printer |
| 51. | S | Stacks of output paper |
| 52. | S | Paper feeding into Line Printer |
| 53. | S | Paper punch machine |
| 54. | S | Close-up of paper punch machine |
| 55. | S | Operator tearing off printout from line printer |

| | | |
|---|---|---|
| 56. | FL | Input-Output Devices |
| 57. | S | Student receives output from output clerk |
| 58. | S | Student looks over output |
| 59. | Demo | Display Printout sheet |
| 60. | OH | FORTRAN Program--Heat |
| 61. | S | Student debugging program |
| 62. | S | Student types changes on keypunch machine |
| 63. | S | Student resubmits program |
| 64. | S | Magnetic Tape Library |
| 65. | S | Cathode Ray Tube |
| 66. | S | Control Panel |

Discuss computer systems overall

Discuss computers in education

# APPENDIX F

# INSTRUMENT FOR EVALUATION OF KNOWLEDGE OF COMPUTERS

STUDENT NUMBER______________ GROUP_________

MULTIPLE CHOICE EXAM - THE COMPUTER

DIRECTIONS: FOR EACH MULTIPLE CHOICE QUESTION THERE IS ONE AND ONLY ONE ANSWER THAT IS CONSIDERED CORRECT. INDICATE YOUR CHOICE OF ANSWER BY CIRCLING THE NUMBER OF THE RESPONSE YOU CONSIDER CORRECT.

PLEASE ANSWER <u>ALL</u> QUESTIONS.

1. Which of the following best defines a flowchart?
   1. A diagram of electrical connections necessary in a computer.
   *2. A step-by-step diagram of all operations involved in solution of a problem.
   3. A diagram of switch positions for a computer program.
   4. A diagram of flow of data from one component of the system to another.

2. In a computer system, what is the function of the Accumulator (Processor)?
   1. Keeps track of the number of operations performed.
   2. Feeds and accepts data from memory.
   *3. Carries out all arithmatical manipulations.
   4. Keeps track of information sequence.

3. Which of the following is not an actual computer operation?
   1. Loop
   2. Add
   3. Jump (Go To)
   *4. Reverse

4. What choice best defines the function of the compiler?
   *1. Rewrites symbolic program to machine language program.
   2. Places cards in proper sequence.
   3. Carries out all mathematical calculations.
   4. Accesses Memory.

5. The Program Counter
   1. Keeps track of the number of programs run.
   2. Keeps track of which program a computer should execute next.
   *3. Keeps track of which step of a program a computer should execute next.
   4. Keeps track of the number of steps performed in a program.

6. The set of instructions that guide the computer is known as
   1. The computer printout.
   *2. The computer program.
   3. The computer input.
   4. The computer flowchart.

7. Which of the following is <u>not</u> a binary device?
   1. A flip-flop switch
   2. A punched card
   3. A magnetic core
   *4. A traffic light

8. Which of the following is <u>not</u> a standard output device?
   *1. Keyboard
   2. Cathode Ray Tube
   3. Punched Card
   4. Paper Tape

9. How does a data card differ from an instruction card?
   1. Data is only numerals.
   2. Instruction cards have a special code.
   3. Data cards have a greater number of punches.
   *4. They do not differ at all.

10. What is meant by "Memory Address?"
   1. The position of the storage register in the computer system.
   2. The type of memory device used.
   *3. The location of a particular cell in the memory register.
   4. The code that will place information into the memory register.

11. When a computer programmer "debugs" his program, he
   *1. Corrects any programming mistakes he may have made.
   2. Rewires some computer circuit so that his program will execute properly.
   3. Writes his program in machine language.
   4. None of the above.

12. A "Subroutine" is a
   1. Special set of instructions used by the memory unit.
   2. Special set of instructions used by the input unit.
   *3. Special circuit which allows the computer to complete its program much more quickly.
   4. A special computer program which performs some specific task only.

13. Which of the following is <u>not</u> a function of the Control Unit?
    *1. Performs all mathematical calculations
    2. Increases Program counter by one
    3. Fetches next instruction word to instruction register.
    4. Activates Instruction Register to execute current instruction.

14. Which of the following statements is <u>false</u>?
    *1. Information can flow directly from input to output in a computer system.
    2. Magnetic Tapes may be used as an output device.
    3. Computers are both extremely rapid and reliable.
    4. The Control Unit cannot store or process data.

15. The "Heart" of the computer system is its
    1. Control Unit
    *2. Memory Device
    3. Output Device
    4. Processor.

16. Information from the input device of a computer is read into
    1. Control Unit
    2. Processor
    *3. Memory
    4. Output Device

17. Instructions are executed
    1. Always in a linear fashion.
    2. In a random fashion.
    *3. In a linear fashion unless instructed to do otherwise
    4. None of the above.

18. Which of the following statements is <u>false</u>?
    1. A cathode ray tube may be used as an output device.
    2. Magnetic tapes can store as much information as thousands of punch cards.
    3. Special keyboards may be used as input devices.
    *4. Magnetic cores may be used as output devices.

19. The compiler is usually part of the
    1. Memory Device.
    *2. Control Unit.
    3. Input Device.
    4. Output Device.

20. The programmer "writes" his program in
    1. Binary Language.
    2. Machine Language.
    *3. Symbolic Language.
    4. Any of the above.

# APPENDIX G

## ITEM ANALYSIS--MEASURE OF KNOWLEDGE OF COMPUTERS

CONTROL GROUP

EVALUATION SERVICES
RAW SCORE DISTRIBUTIONS

20 ITEMS ON TEST 4201 APRIL 1971

| RAW SCORE | FREQUENCY | CUMULATIVE FREQUENCY | PERCENTILE RANK | STANDARD SCORE |
|---|---|---|---|---|
| 17 | 1 | 1 | 99 | 85.4 |
| 14 | 2 | 3 | 98 | 73.7 |
| 13 | 1 | 4 | 96 | 69.8 |
| 12 | 5 | 9 | 93 | 65.9 |
| 11 | 7 | 16 | 87 | 62.0 |
| 10 | 10 | 26 | 79 | 58.1 |
| 9 | 10 | 36 | 70 | 54.2 |
| 8 | 20 | 56 | 55 | 50.3 |
| 7 | 20 | 76 | 36 | 46.4 |
| 6 | 8 | 84 | 23 | 42.6 |
| 5 | 12 | 96 | 13 | 38.7 |
| 4 | 5 | 101 | 5 | 34.8 |
| 3 | 3 | 104 | 1 | 30.9 |

MEAN 7.90
STANDARD DEVIATION 2.57
VARIANCE 06.65
STANDARD SCORE HAS MEAN OF 50 AND STANDARD DEVIATION OF 10

CONTROL GROUP

ITEM ANALYSIS — TEST 4201 — 20 ITEMS — 104 STUDENTS

PERCENTAGES — UPPER 27% — MIDDLE 46% — LOWER 27%

| ITEM | KEY | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | OMIT | | | ERROR | | | DIFF | DISC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 0 | 0 | 7 | 86 | 63 | 61 | 0 | 0 | 0 | 14 | 38 | 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 25 |
| 2 | 3 | 11 | 13 | 14 | 43 | 38 | 39 | 18 | 13 | 11 | 29 | 38 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 87 | 7 |
| 3 | 4 | 14 | 38 | 46 | 18 | 15 | 4 | 7 | 15 | 32 | 61 | 31 | 18 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 64 | 43 |
| 4 | 1 | 46 | 17 | 14 | 29 | 42 | 54 | 18 | 13 | 4 | 7 | 29 | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 76 | 32 |
| 5 | 3 | 21 | 33 | 43 | 4 | 15 | 11 | 36 | 27 | 11 | 39 | 25 | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 75 | 25 |
| 6 | 2 | 0 | 2 | 14 | 82 | 63 | 43 | 7 | 23 | 18 | 11 | 13 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 39 |
| 7 | 4 | 0 | 8 | 7 | 21 | 42 | 32 | 0 | 15 | 29 | 79 | 35 | 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 54 | 47 |
| 8 | 1 | 39 | 35 | 7 | 29 | 38 | 57 | 21 | 8 | 11 | 11 | 19 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 71 | 32 |
| 9 | 4 | 7 | 13 | 21 | 25 | 33 | 25 | 7 | 10 | 25 | 61 | 44 | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 56 | 32 |
| 10 | 3 | 21 | 13 | 18 | 4 | 6 | 11 | 54 | 29 | 0 | 21 | 52 | 71 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 72 | 54 |
| 11 | 1 | 86 | 71 | 57 | 4 | 6 | 21 | 7 | 10 | 11 | 4 | 13 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29 | 29 |
| 12 | 3 | 0 | 2 | 0 | 7 | 21 | 11 | 18 | 23 | 46 | 75 | 54 | 43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 32 |
| 13 | 1 | 57 | 33 | 36 | 14 | 38 | 29 | 14 | 23 | 14 | 14 | 6 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 21 |
| 14 | 1 | 43 | 65 | 14 | 18 | 6 | 21 | 11 | 2 | 4 | 29 | 27 | 61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 55 | 29 |
| 15 | 2 | 21 | 21 | 29 | 64 | 56 | 25 | 0 | 0 | 4 | 14 | 23 | 43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 50 | 39 |
| 16 | 3 | 11 | 8 | 25 | 57 | 67 | 61 | 29 | 23 | 11 | 4 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 79 | 18 |
| 17 | 3 | 18 | 35 | 32 | 0 | 2 | 0 | 75 | 52 | 46 | 7 | 10 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 | 29 |
| 18 | 4 | 21 | 48 | 46 | 7 | 15 | 25 | 4 | 6 | 14 | 68 | 31 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 63 | 54 |
| 19 | 2 | 25 | 31 | 50 | 36 | 15 | 7 | 21 | 25 | 29 | 18 | 29 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 82 | 29 |
| 20 | 3 | 25 | 31 | 25 | 7 | 8 | 18 | 25 | 19 | 11 | 43 | 42 | 46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 82 | 14 |

CARDIAC GROUP

EVALUATION SERVICES
RAW SCORE DISTRIBUTIONS

20 ITEMS ON TEST 4202 APRIL 1971

| RAW SCORE | FREQUENCY | CUMULATIVE FREQUENCY | PERCENTILE RANK | STANDARD SCORE |
|---|---|---|---|---|
| 17 | 1 | 3 | 97 | 70.8 |
| 16 | 3 | 6 | 93 | 67.7 |
| 15 | 3 | 9 | 88 | 64.6 |
| 14 | 2 | 11 | 85 | 61.5 |
| 13 | 1 | 12 | 83 | 58.4 |
| 12 | 12 | 24 | 73 | 55.2 |
| 11 | 6 | 30 | 60 | 52.1 |
| 10 | 7 | 37 | 50 | 49.0 |
| 9 | 12 | 49 | 36 | 45.9 |
| 8 | 10 | 59 | 20 | 42.8 |
| 7 | 3 | 62 | 11 | 39.7 |
| 6 | 2 | 64 | 7 | 36.6 |
| 5 | 1 | 65 | 5 | 33.4 |
| 4 | 2 | 67 | 2 | 30.3 |
| 2 | 1 | 68 | 0 | 24.1 |

MEAN 10.30
STANDARD DEVIATION 3.21
VARIANCE 10.31
STANDARD SCORE HAS MEAN OF 50 AND STANDARD DEVIATION OF 10

CARDIAC GROUP

ITEM ANALYSIS TEST 4202 20 ITEMS 68 STUDENTS

PERCENTAGES UPPER 27$ MIDDLE 46% LOWER 27%

| ITEM | KEY | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | OMIT | | | ERROR | | | DIFF | DISC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 0 | 3 | 0* | 89 | 81 | 72* | 0 | 0 | 6* | 11 | 16 | 22* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 19 | 17 |
| 2 | 3 | 0 | 3 | 11* | 33 | 34 | 39* | 67 | 50 | 22* | 0 | 13 | 28* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 53 | 45 |
| 3 | 4 | 11 | 31 | 28* | 6 | 13 | 17* | 0 | 6 | 11* | 83 | 50 | 44* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 43 | 39 |
| 4 | 1 | 72 | 34 | 0* | 22 | 28 | 28* | 6 | 13 | 28* | 0 | 25 | 44* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 65 | 72 |
| 5 | 3 | 0 | 9 | 28* | 6 | 13 | 17* | 89 | 59 | 39* | 6 | 19 | 17* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 38 | 50 |
| 6 | 2 | 0 | 0 | 6* | 83 | 63 | 50* | 6 | 19 | 6* | 11 | 19 | 39* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 35 | 33 |
| 7 | 4 | 0 | 0 | 17* | 17 | 34 | 39* | 0 | 6 | 17* | 83 | 59 | 28* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 43 | 55 |
| 8 | 1 | 61 | 38 | 22* | 33 | 44 | 50* | 6 | 13 | 11* | 0 | 6 | 17* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 60 | 39 |
| 9 | 4 | 0 | 9 | 22* | 39 | 25 | 50* | 0 | 6 | 11* | 61 | 59 | 17* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 51 | 44 |
| 10 | 3 | 0 | 6 | 6* | 0 | 0 | 17* | 94 | 66 | 39* | 6 | 28 | 39* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 34 | 55 |
| 11 | 1 | 57 | 44 | 28* | 0 | 0 | 17* | 11 | 9 | 6* | 22 | 47 | 50* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 54 | 39 |
| 12 | 4 | 0 | 6 | 0* | 6 | 16 | 6* | 22 | 25 | 56* | 72 | 53 | 39* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 46 | 33 |
| 13 | 1 | 78 | 53 | 33* | 6 | 6 | 28* | 0 | 22 | 0* | 17 | 19 | 39* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 46 | 45 |
| 14 | 1 | 78 | 63 | 39* | 6 | 16 | 0* | 0 | 3 | 0* | 17 | 19 | 61* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 40 | 39 |
| 15 | 2 | 22 | 31 | 17* | 67 | 50 | 61* | 0 | 3 | 0* | 11 | 16 | 22* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 43 | 6 |
| 16 | 3 | 6 | 13 | 6* | 11 | 38 | 56* | 78 | 47 | 39* | 0 | 3 | 0* | 0 | 0 | 0* | 6 | 0 | 0* | 0 | 0 | 0* | 47 | 39 |
| 17 | 3 | 17 | 50 | 56* | 0 | 0 | 6* | 83 | 44 | 39* | 0 | 6 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 47 | 44 |
| 18 | 4 | 28 | 34 | 56* | 6 | 9 | 17* | 0 | 3 | 6* | 67 | 53 | 22* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 51 | 45 |
| 19 | 2 | 33 | 25 | 56* | 33 | 41 | 22* | 28 | 25 | 17* | 17 | 9 | 6* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 69 | 0 |
| 20 | 3 | 28 | 41 | 56* | 6 | 16 | 6* | 33 | 6 | 11* | 33 | 38 | 28* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 85 | 22 |

CARDIAC GROUP

EVALUATION SERVICES
RAW SCORE DISTRIBUTIONS

20 ITEMS ON TEST 4203 APRIL 1971

| RAW SCORE | FREQUENCY | CUMULATIVE FREQUENCY | PERCENTILE RANK | STANDARD SCORE |
|---|---|---|---|---|
| 18 | 2 | 2 | 99 | 74.4 |
| 17 | 2 | 4 | 97 | 71.2 |
| 16 | 4 | 8 | 94 | 68.0 |
| 15 | 3 | 11 | 92 | 64.8 |
| 14 | 5 | 16 | 88 | 61.6 |
| 13 | 14 | 30 | 80 | 58.4 |
| 12 | 13 | 43 | 69 | 55.3 |
| 11 | 13 | 56 | 58 | 52.1 |
| 10 | 26 | 72 | 46 | 48.9 |
| 9 | 14 | 86 | 34 | 45.7 |
| 8 | 11 | 97 | 23 | 42.5 |
| 7 | 12 | 109 | 14 | 39.3 |
| 6 | 4 | 113 | 7 | 36.1 |
| 5 | 4 | 117 | 4 | 32.9 |
| 4 | 2 | 119 | 1 | 29.7 |
| 2 | 1 | 120 | 0 | 23.3 |

MEAN 10.23
STANDARD DEVIATION 3.13
VARIANCE 09.81
STANDARD SCORE HAS MEAN OF 50 AND STANDARD DEVIATION OF 10

SLIDE GROUP

ITEM ANALYSIS TEST 4203 20 ITEMS 120 STUDENTS

PERCENTAGES UPPER 27% MIDDLE 46% LOWER 27%

| ITEM | KEY | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | OMIT | | | ERROR | | | DIFF | DISC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2* | 0 | 0 | 3* | 88 | 88 | 59* | 0 | 0 | 0* | 13 | 13 | 38* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 20 | 29 |
| 2 | 3* | 3 | 2 | 3* | 34 | 55 | 44* | 56 | 25 | 6* | 6 | 18 | 47* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 72 | 50 |
| 3 | 4* | 28 | 32 | 41* | 13 | 13 | 13* | 6 | 16 | 19* | 53 | 39 | 28* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 60 | 25 |
| 4 | 1* | 56 | 36 | 25* | 16 | 29 | 28* | 6 | 7 | 12* | 22 | 29 | 34* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 62 | 31 |
| 5 | 3* | 16 | 21 | 25* | 6 | 13 | 3* | 69 | 45 | 31* | 9 | 21 | 41* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 52 | 38 |
| 6 | 2* | 0 | 4 | 3* | 81 | 63 | 50* | 16 | 21 | 28* | 3 | 13 | 19* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 36 | 31 |
| 7 | 2* | 0 | 2 | 0* | 0 | 4 | 3* | 0 | 13 | 28* | 100 | 82 | 69* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 17 | 31 |
| 8 | 1* | 72 | 50 | 34* | 22 | 38 | 47* | 0 | 6 | 3* | 6 | 7 | 16* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 48 | 38 |
| 9 | 4* | 9 | 11 | 34* | 13 | 21 | 41* | 0 | 7 | 6* | 78 | 61 | 19* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 46 | 59 |
| 10 | 3* | 6 | 14 | 9* | 0 | 0 | 6* | 63 | 38 | 31* | 31 | 48 | 53* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 57 | 32 |
| 11 | 1* | 97 | 91 | 63* | 0 | 4 | 13* | 0 | 0 | 25* | 3 | 5 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 15 | 34 |
| 12 | 4* | 13 | 18 | 13* | 9 | 13 | 19* | 3 | 16 | 31* | 75 | 54 | 38* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 45 | 37 |
| 13 | 1* | 91 | 64 | 34* | 0 | 20 | 31* | 6 | 4 | 16* | 3 | 13 | 19* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 37 | 57 |
| 14 | 1* | 91 | 71 | 47* | 6 | 2 | 6* | 0 | 4 | 3* | 3 | 23 | 44* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 30 | 44 |
| 15 | 2* | 6 | 21 | 26* | 88 | 66 | 56* | 0 | 0 | 0* | 6 | 13 | 19* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 31 | 32 |
| 16 | 3* | 19 | 29 | 13* | 28 | 36 | 63* | 53 | 34 | 22* | 0 | 0 | 3* | 0 | 0 | 0* | 0 | 2 | 0* | 0 | 0 | 0* | 64 | 31 |
| 17 | 3* | 41 | 61 | 75* | 0 | 0 | 3* | 50 | 29 | 9* | 9 | 11 | 13* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 71 | 41 |
| 18 | 4* | 6 | 29 | 63* | 0 | 5 | 9* | 3 | 16 | 13* | 91 | 50 | 16* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 48 | 75 |
| 19 | 2* | 28 | 21 | 38* | 31 | 25 | 6* | 28 | 29 | 25* | 13 | 25 | 31* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 78 | 25 |
| 20 | 3* | 19 | 25 | 41* | 3 | 11 | 6* | 41 | 21 | 13* | 38 | 43 | 41* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 76 | 28 |

ALL SUBJECTS

EVALUATION SERVICES
RAW SCORE DISTRIBUTIONS

20 ITEMS ON TEST 8000 JUNE 1971

| RAW SCORE | FREQUENCY | CUMULATIVE FREQUENCY | PERCENTILE RANK | STANDARD SCORE |
|---|---|---|---|---|
| 19 | 1 | 1 | 99 | 79.7 |
| 17 | 2 | 3 | 99 | 73.4 |
| 16 | 10 | 13 | 97 | 70.2 |
| 15 | 6 | 19 | 94 | 67.0 |
| 14 | 19 | 38 | 90 | 63.8 |
| 13 | 14 | 52 | 84 | 60.6 |
| 12 | 34 | 86 | 76 | 57.4 |
| 11 | 21 | 107 | 66 | 54.2 |
| 10 | 38 | 145 | 56 | 51.1 |
| 9 | 38 | 183 | 43 | 47.9 |
| 8 | 32 | 215 | 31 | 44.7 |
| 7 | 29 | 244 | 21 | 41.5 |
| 6 | 24 | 268 | 12 | 38.3 |
| 5 | 10 | 278 | 6 | 35.1 |
| 4 | 8 | 286 | 3 | 32.0 |
| 3 | 3 | 289 | 1 | 28.8 |
| 2 | 2 | 291 | 0 | 25.6 |

MEAN 9.65
STANDARD DEVIATION 3.14
VARIANCE 09.88
STANDARD SCORE HAS MEAN OF 50 AND STANDARD DEVIATION OF 10

ALL SUBJECTS

ITEM ANALYSIS TEST 8000 20 ITEMS 291 STUDENTS

PERCENTAGES UPPER 27% MIDDLE 46% LOWER 27%

| ITEM | KEY | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | OMIT | | | ERROR | | | DIFF | DISC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2* | 1 | 0 | 4* | 87 | 78 | 62* | 0 | 0 | 1* | 12 | 22 | 33* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 24 | 25 |
| 2 | 3* | 1 | 8 | 9* | 32 | 47 | 40* | 59 | 18 | 13* | 8 | 27 | 38* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 73 | 46 |
| 3 | 4* | 24 | 30 | 41* | 13 | 13 | 12* | 6 | 13 | 22* | 56 | 44 | 24* | 0 | 0 | 0* | 0 | 0 | 1* | 0 | 0 | 0* | 58 | 32 |
| 4 | 1* | 58 | 30 | 13* | 17 | 33 | 41* | 8 | 13 | 12* | 18 | 24 | 35* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 67 | 45 |
| 5 | 3* | 9 | 21 | 40* | 5 | 13 | 9* | 68 | 40 | 23* | 18 | 26 | 28* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 57 | 45 |
| 6 | 2* | 0 | 2 | 8* | 79 | 64 | 47* | 13 | 20 | 19* | 8 | 14 | 26* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 36 | 32 |
| 7 | 4* | 0 | 3 | 8* | 10 | 19 | 33* | 1 | 13 | 23* | 88 | 66 | 36* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 36 | 52 |
| 8 | 1* | 64 | 36 | 24* | 28 | 40 | 49* | 4 | 10 | 9* | 4 | 13 | 18* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 59 | 40 |
| 9 | 4* | 8 | 10 | 27* | 21 | 31 | 32* | 1 | 10 | 13* | 71 | 49 | 28* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 51 | 43 |
| 10 | 3* | 8 | 13 | 13* | 0 | 4 | 9* | 69 | 40 | 21* | 23 | 44 | 58* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 57 | 48 |
| 11 | 1* | 83 | 73 | 54* | 3 | 6 | 12* | 3 | 7 | 17* | 12 | 14 | 18* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 29 | 29 |
| 12 | 4* | 9 | 9 | 3* | 8 | 16 | 14* | 12 | 21 | 42* | 72 | 54 | 41* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 45 | 31 |
| 13 | 1* | 86 | 44 | 36* | 4 | 22 | 33* | 5 | 16 | 13* | 5 | 19 | 18* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 47 | 50 |
| 14 | 1* | 83 | 61 | 29* | 6 | 7 | 13* | 1 | 4 | 4* | 9 | 27 | 54* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 41 | 54 |
| 15 | 2* | 19 | 20 | 27* | 71 | 64 | 42* | 0 | 1 | 1* | 10 | 16 | 29* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 40 | 29 |
| 16 | 3* | 14 | 19 | 12* | 27 | 47 | 69* | 58 | 31 | 17* | 0 | 2 | 3* | 0 | 0 | 0* | 1 | 1 | 0* | 0 | 0 | 0* | 66 | 41 |
| 17 | 3* | 36 | 47 | 50* | 0 | 1 | 1* | 56 | 44 | 33* | 8 | 7 | 15* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 55 | 23 |
| 18 | 4* | 18 | 37 | 54* | 3 | 9 | 19* | 8 | 7 | 10* | 72 | 47 | 17* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 55 | 55 |
| 19 | 2* | 21 | 31 | 45* | 36 | 26 | 4* | 28 | 23 | 27* | 15 | 20 | 24* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 77 | 32 |
| 20 | 4* | 23 | 30 | 41* | 5 | 9 | 14* | 16 | 16 | 22* | 46 | 46 | 23* | 0 | 0 | 0* | 0 | 0 | 0* | 0 | 0 | 0* | 60 | 23 |

# APPENDIX H

# INSTRUMENT TO MEASURE ATTITUDE TOWARD COMPUTERS

STUDENT NUMBER________________ GROUP___________

## SEMANTIC DIFFERENTIAL

On each line below there are two adjectives representing opposites. Each set of adjectives is separated by five lines. Please rate the concept "COMPUTER" by checking one of the five categories between each pair of terms, in order to indicate which of the two opposites best describes the concept. Thus, if the two words listed are black and white, you would check the line closest to black if you believe this term is the most descriptive, the line closest to white if that is most descriptive and one of the three middle terms to represent combinations of black and white. Although some of the parts may seem unrelated to the concept, rate them as best you can.

PLEASE MAKE A CHECK MARK (✓) ON EVERY LINE

| | | | | | | |
|---|---|---|---|---|---|---|
| SLOW | ____ | ____ | ____ | ____ | ____ | FAST |
| STRONG | ____ | ____ | ____ | ____ | ____ | WEAK |
| WORTHWHILE | ____ | ____ | ____ | ____ | ____ | WORTHLESS |
| GOOD | ____ | ____ | ____ | ____ | ____ | BAD |
| SIMPLE | ____ | ____ | ____ | ____ | ____ | COMPLEX |
| HARMFUL | ____ | ____ | ____ | ____ | ____ | BENEFICIAL |
| SAFE | ____ | ____ | ____ | ____ | ____ | DANGEROUS |
| FLEXIBLE | ____ | ____ | ____ | ____ | ____ | RIGID |
| NECESSARY | ____ | ____ | ____ | ____ | ____ | UNNECESSARY |
| LIKE | ____ | ____ | ____ | ____ | ____ | DISLIKE |
| EFFICIENT | ____ | ____ | ____ | ____ | ____ | INEFFICIENT |
| USEFUL | ____ | ____ | ____ | ____ | ____ | USELESS |
| APPROACHABLE | ____ | ____ | ____ | ____ | ____ | UNAPPROACHABLE |
| BORING | ____ | ____ | ____ | ____ | ____ | INTERESTING |
| ACCURATE | ____ | ____ | ____ | ____ | ____ | INACCURATE |
| UNDERSTANDABLE | ____ | ____ | ____ | ____ | ____ | INCOMPREHENSIBLE |
| EASY TO USE | ____ | ____ | ____ | ____ | ____ | HARD TO USE |
| PRODUCTIVE | ____ | ____ | ____ | ____ | ____ | DESTRUCTIVE |
| FALLIBLE | ____ | ____ | ____ | ____ | ____ | INFALLIBLE |
| IMPORTANT | ____ | ____ | ____ | ____ | ____ | UNIMPORTANT |

# APPENDIX I

## MEASURE OF ATTITUDE TOWARD COMPUTER ASSISTED INSTRUCTION

STUDENT NUMBER____________ GROUP_____________

In this Attitude Scale, the term "Computer Assisted Instruction" refers to a method of instruction in which subject matter is presented by a computer. The person is instructed and makes responses by means of a "terminal"; usually a device similar to an electric typewriter.
There are 20 statements about "Computer Assisted Instruction." Consider each statement separately and indicate the extent to which you agree or disagree with it by circling the appropriate symbol to the right of the statement.

The symbols used are:
- SA - Strongly Agree
- A - Agree
- N - No opinion
- D - Disagree
- SD - Strongly Disagree

ALL RESPONSES WILL BE TREATED CONFIDENTIALLY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. | I am very interested in learning about computer assisted instruction. | 1. | SA | A | N | D | SD |
| 2. | Teaching machines can individualize instruction more effectively than other methods. | 2. | SA | A | N | D | SD |
| 3. | Computer assisted instruction is an impersonal teaching approach. | 3. | SA | A | N | D | SD |
| 4. | Computer assisted instruction will improve instructional programs. | 4. | SA | A | N | D | SD |
| 5. | Computer assisted instruction challenges the student to do his best. | 5. | SA | A | N | D | SD |
| 6. | I would prefer to take a course by computer rather than by conventional instruction. | 6. | SA | A | N | D | SD |
| 7. | Use of teaching machines causes students to feel isolated. | 7. | SA | A | N | D | SD |
| 8. | Use of the computer for data processing activities is more important than use of the computer for instruction. | 8. | SA | A | N | D | SD |
| 9. | Computer assisted instruction is based on the same principles as good classroom teaching. | 9. | SA | A | N | D | SD |
| 10. | I am uneasy about the use of computers for teaching youth. | 10. | SA | A | N | D | SD |
| 11. | Computer assisted instruction can develop problem-solving techniques. | 11. | SA | A | N | D | SD |
| 12. | Teaching machines are inflexible mediums. | 12. | SA | A | N | D | SD |
| 13. | Most elementary students would be adversely affected by computerized instruction. | 13. | SA | A | N | D | SD |
| 14. | I would prefer to take a course by conventional instruction rather than by computer assisted instruction. | 14. | SA | A | N | D | SD |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 15. | Teaching by machine will tend to dehumanize the curriculum. | 15. | SA | A | N | D | SD |
| 16. | The advocates for computer assisted instruction should press harder for its adoption. | 16. | SA | A | N | D | SD |
| 17. | By using computer assisted instruction, a teacher will probably become a better teacher. | 17. | SA | A | N | D | SD |
| 18. | Computer assisted instruction threatens the teacher's role. | 18. | SA | A | N | D | SD |
| 19. | Educators will find computer assisted instruction techniques successful. | 19. | SA | A | N | D | SD |
| 20. | Computer assisted instruction hinders the social development of the student. | 20. | SA | A | N | D | SD |