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A Curriculum Model For Computer Literacy For Elementary School Teachers

Kathryn V. Williams
University of the Pacific

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A CURRICULUM MODEL FOR COMPUTER LITERACY
FOR ELEMENTARY SCHOOL TEACHERS

A Dissertation
Presented to
The Graduate Faculty
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In Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

by
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Dated May 2, 1963
A CURRICULUM MODEL FOR COMPUTER LITERACY
FOR ELEMENTARY SCHOOL TEACHERS

The purpose of this study was to provide a model for computer literacy curriculum for elementary school teachers. The educational philosophy which guided the development of the curriculum was that of John Dewey. Subjects in the study were 149 elementary school teachers in Stockton Unified School District. Data were collected using a survey developed by the researcher. The following categories of information were obtained: years of teaching experience; level of mathematics training; previous computer training and experience; attitudes toward computers and their use in education; commitment to learning about computers; and perceived importance of potential computer literacy topics.

These hypotheses were tested with Spearman's rho: 1) number of college mathematics classes taken was correlated with attitude toward computers and 2) years of teaching was correlated with attitude toward computers. Statistical analysis revealed a significant positive correlation between attitude toward computers and number of college mathematics courses taken, and a significant negative correlation between attitude toward computers and number of years of teaching. The more mathematics classes taken in college, the more positive was the attitude toward computers. The more years the individual had taught, the less positive was the attitude toward computers.

These hypotheses were tested with multiple regression: 1) attitude toward computers was correlated with computer literacy topics perceived to be important and 2) commitment to learning about computers was correlated with computer literacy topics perceived to be important. Statistical analysis indicated teachers with the most positive attitudes toward computers and the strongest commitment to learning about computers believed the most important computer literacy topics were those focusing on operating and programming computers.

The results of the data analysis and the philosophy of John Dewey served to guide the preparation of an introductory computer literacy curriculum for elementary teachers. It was composed of six separate lessons, and required the use of a microcomputer. The aims of the curriculum were to: 1) learn to operate a simple computer, 2) understand the steps of a simple program and explain what a simple program does, 3) find errors in simple programs, 4) make modifications in simple programs, and 5) write simple programs to solve a single problem and to solve several similar problems.
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Computers pervade American lives. Not only has computer use in government and business increased tremendously over the past decades, but computer use is growing in education as well. Initially the use of computers in education was focused mainly on data processing and administrative functions. However, with the advent of relatively inexpensive microcomputers, classroom teachers are more likely to have computers available for use with students. Out of this availability of classroom computers has arisen these expectations: 1) teachers will use computers for more effective management and instruction in their classes, and 2) teachers will familiarize students with computers so the students will be able to function effectively in a computer oriented society. This second expectation has come to be identified as the need for computer literacy for students. Computer literacy has been described and defined in a variety of ways. Although there seems to be agreement that computer literacy involves fostering positive attitudes toward computers and imparting some knowledge of them, there is no consensus regarding what specific skills, attitudes and knowledge comprise computer literacy. Nor is
there agreement about the competence needed by teachers to enable them to utilize computers in instruction and to familiarize students with computers.

**Computers in Society**

During the decades of the 1960's and 1970's computer use became increasingly common for data processing of credit cards, bank accounts, payrolls, accounting and other mundane affairs, while at the same time computer use in government and national defense also increased. The major cause of this increase was an approximate 30% decrease in computer hardware costs. Continuing cost reductions made possible the use of fairly inexpensive microcomputers in a wide range of products such as calculators, microwave ovens, cars, cash registers, and personal computers. The number of computer systems in use also grew rapidly. Estimates suggest there were 700,000 computers in the United States in 1980 and there will be 1,100,000 in 1985. This is an enormous increase from 5,500 computers in use in the U.S. in the mid-1960's. Decreased cost of computer hardware allows more computer systems and microcomputers to be utilized;

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this means the individual American involuntarily but inexorably has become a consumer of computer services.

A number of researchers predict a revolutionary change in computer use during the 1980's and 1990's.3 Because of the dramatic drop in computer hardware costs and the equally dramatic increase in the power of personal microcomputers, many individuals who previously had only indirect contact will have direct contact with computers.4 Computers will become as common as other present technology. Christopher Evans, a leading authority on microprocessors in the late 1970's, summarizes this change:

"... We are shortly moving into the phase where computers will become one of the cheapest pieces of technology on earth—cheaper than TV sets (they already are), cheaper than portable typewriters, cheaper even than transistor radios. They will also, for exactly the same reasons, become the most common pieces of technology in the world, and the most useful."5

Computers in Education

Computer use in education grew during the 1970's and is predicted to continue growing. This trend can be seen in these statistics and projections: 46,000 microcomputers were estimated to be in the schools in 1980, and this number is predicted to rise to 105,000 by 1982; ninety


4Dertouzos and Moses, p. xiii.

5Evans, p. 59.
percent of all schools used computers for instruction and/or administrative purposes in 1981; in 1979 half of all secondary students used computers; and at least 2,660 high schools and junior high schools taught computer literacy. A large number of researchers and educators believe that this increased use of computers could bring about a revolution and reform in education. Computers are often used in administrative data processing. Aside from this use, there are a variety of applications of computers in education at the classroom level.

**Management.** Computers may be used to keep track of paperwork usually done by hand, such as attendance records, test administration and scoring, calculation of grades, diagnosis of student skills, and prescriptions of appropriate learning materials. This type of use may be referred to as CMI (Computer Managed Instruction).  

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Drill and practice. Computers are used for drill and practice exercises. Students can practice a skill or learn specific information and have their accuracy evaluated immediately. For example, drill and practice of foreign language vocabulary, multiplication tables, verb forms, or dates in history are readily accomplished with a computer. The PLATO system marketed by Control Data Corporation is a well known drill and practice software system. Drill and practice is often criticized as not fostering a conceptual understanding of material, but it is effective in memorization of materials.9

Tutorials. A third use of computers is in teaching concepts to students. The most common example in this category is in high school math and science instruction. Graphic displays of a math or science concept are generated on the computer to facilitate learning.10 Problem solving skills can be developed and logical thinking encouraged.11

Simulations. Computers are used to generate simulations in which particular situations are created with which the student interacts. For example, in the historical simulation, "Oregon," the student takes the role of a

9Moses, p. 7.
11Souviney, p. 53.
pioneer traveling from Independence, Missouri, to the West Coast. Faced with challenges such as bad weather, poor trails, Indian attacks, and other similar problems, the student tries to make decisions that will allow him to survive the journey. Simulations focus on economics, science, arithmetic, medicine and other areas. Because of the similarity to games, students are often very enthusiastic about simulations.12

**Computer programming.** Another use of computers in education focuses on learning simple programming languages and writing computer programs. This contrasts with the other uses of computers in that the student creates his own computer programs to meet some goal or solve some problem rather than just interacting with a program written by someone else. The student controls the computer. This use of the computer is likely to be common in the future in mathematics, science, and business, as well as in other disciplines.13

**Need for Computer Literacy**

Computer use is already very widespread in American society, and computers are rapidly becoming a part of

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education. Many educators recognize that computer literacy is becoming a necessary basic skill. As Molnar points out, schools must begin to address this problem:

There is a national need to foster computer literacy. Further, if we are to meet this need, we must insure that high school graduates have an understanding of the uses and applications of the computer in society and its effects on their everyday lives. We must permit students to use the computer as it would typically be used in business, science, and government. We must increase the quality of education through the introduction of computer related curricula in a wide variety of academic subjects at all levels of education.

A nation concerned with its social needs and economic growth cannot be indifferent to the problems of literacy. If we are to reap the benefits of science-driven industries, we must develop a computer literate society.

Thus, computer literacy is seen as necessary for participation in society. If all students are to become computer literate and have computers available to them, the schools must take the responsibility for computer literacy. For this to occur, teachers themselves must be computer literate.

Computer Illiteracy

Although there is much agreement that computer literacy is desirable, few teachers are very knowledgeable in this area. In a study done by the Minnesota Educational Computing Consortium, 85% of the 1,300 teachers surveyed agree it is necessary for high school teachers to have basic knowledge of computers, but only 39% of those teachers

14Brents, p. 17.
15Molnar, p. 33.
feel they know enough about computers to use them for instruction. Teachers have not learned how to use computers for a number of reasons. One cause is that teachers are not required to know about computers for certification, and in fact very few college or university programs exist that train teachers to be familiar with computers. In addition, the idea of computers in education and the necessity for computer literacy is relatively new. Many present teachers completed their training before the need was identified. Thus, one of the major causes of insufficient knowledge about computers is lack of opportunity to learn.

However, the factors related to computer illiteracy appear to be more complex than this. Many teachers seem reluctant to learn about computers because the topic is very new to them and requires novel approaches to thinking and teaching. As Smith points out, although some computer science professionals become almost obsessively fascinated with computers, the emotional response of the novice is not necessarily characterized by such acceptance:

... The person just introduced to a computer for the first time may exhibit a markedly different set of emotions based on fear, awe, and general uncertainty. Sometimes the emotions involved may be more positive: they are in any event seldom neutral.

17Milner, pp. 544-45. 18Milner, p. 545.
19Smith, p. 13.
Also, there is fear that computers will eventually eliminate some teaching positions, so facilitating integration of computers in the curriculum may be seen by some teachers as foolhardy and self-destructive. Therefore, the emotional response of teachers to computers appears to be a factor conducive to computer illiteracy.

This resistance to change should not be surprising. It is not uncommon for professionals to present innovations that appear to be desirable, only to have these innovations rejected by those who apparently would profit from them. Foster addresses the factors related to rejection of innovations. He cites two reasons why this may happen:

The innovation, in the total life context of the community, is not in fact an improvement. It is better called a "pseudo-improvement," since its social and other costs outweigh its advantages.

The innovation may by all reasonable standards be well planned and represent a genuine improvement, but the people for whom it is intended may not perceive the advantages, or they may be reluctant to try it because of cultural, social, and psychological barriers that discourage innovation.

Although there is an expressed need for computer literate teachers, in general teachers have not acquired facility in using computers. A number of factors appear related to this.

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20Souviney, p. 56.

Definitions of Computer Literacy

Computer literacy is described in a number of ways, with varying emphasis on a wide number of computer related skills and topics. The National Council of Supervisors of Mathematics refers to it as one of ten basic skill areas:

It is important for all citizens to understand what computers can and cannot do. Students should be aware of the many uses of computers in society, such as their use in teaching/learning, financial transactions, and information storage and retrieval. The "mystique" surrounding computers is disturbing and can put persons with no understanding of computers at a disadvantage. The increasing use of computers by government, industry, and business demands an awareness of computer use and limitations.\(^{22}\)

The Committee on Computer Education of the Conference Board of the Mathematical Sciences describes computer literacy as composed of three parts, knowing what computers do, how they are used, and how solutions to problems are translated into computer programs. The Committee summarizes computer literacy as the following:

1. Computer capabilities. As a result of some direct use of a computer, mainly using preprogrammed software, the student will be aware of the essential capabilities and limits of computers.

2. Computer applications. The student will explore a wide range of the uses of computers and will be able to identify the impact of these uses on the individual.

3. Computer algorithms. The student will understand the purpose of translating a problem into

an algorithm and how it is represented in a flow chart. How the computer executes the program will be discussed if time and equipment are available.23

Johnson examines a number of position statements by business and industry groups, educators, and computer professionals and devises a list of topics to be included in a computer literacy course. Because her survey includes such a wide range of sources, her list is extensive. She includes these topics:

1. Technological advances - that have made possible data processing as we know it today - historical perspectives, stages of mechanism.

2. Nontechnical computer vocabulary - to help make communication easier with others in our increasingly computer-oriented society.

3. Computer anatomy - what it is, what it is not, configuration of equipment.

4. Computer capabilities and limitations - nontechnical and low-technical aspects of the capabilities and limitations of computers; system capabilities, what it can do or cannot do; input/output capacity, speed of CPU.

5. Uses of computers - recent technology and projections as to what is to come in computing, i.e., telecommunications, simulation of traffic patterns, CAI, information storage, AIM-ARM, control satellites, daily directory update, sort subscription lists.

6. Business and scientific applications - be able to read an article in a newspaper or listen to a news report concerning business or scientific applications of computers and know, in general, what is being discussed.

7. Scientific method of problem solving—introductory skills that enable one to conceptualize problems designed to solve problems scientifically.

8. Computer programming—represent problems in syntax of a language; programming if computer is available.

9. Problem-solving tool—use computer as a tool to solve problems in subject matter of choice, could be accounting, mathematics, English.

10. Social implications—organizational change, privacy, career paths available with additional technical training, entry-level jobs available upon completion of high school.

11. Futuristics—innovation, new technology, trends in artificial intelligence, and robotics.24

Eisele sees computer literacy as a vital part of the curriculum of schools. His approach to computer literacy emphasizes practical knowledge of computers and includes skills all individuals must have to function in society. Positive attitudes toward computers and the ability to use them in everyday situations predominate. He identifies the goals of such a curriculum to be:

1. Developing skills to use computer applications which bear on persistent life situations such as communications, transportation, education, governance, consumerism, entertainment, and employment;

2. Developing a computing proficiency as a skill for everyday use at home and on the job;

3. Developing ethical practices in providing computer services to others.

4. Developing ethical practices of consumption of

of computer services;

3. Developing positive attitudes toward the pervasive role of computers in contemporary society.²⁵

The Minnesota Educational Computing Consortium, supported by a grant from the National Science Foundation, has identified specific content areas and related objectives of computer literacy. This is based on a survey of the literature, including curriculum materials, articles, and texts, as well as information supplied by individuals surveyed. Six general areas are identified: hardware; programming and algorithms; software and data processing; applications; impact; and attitudes, values, and motivation.²⁶ Because much time and many resources have been invested in this study, this outline of computer literacy objectives is very thorough and well defined. (See Appendix B for objectives in each area.)

Many descriptions of computer literacy can be found. Although they all suggest the goal of computer literacy is to familiarize individuals with computers, the means toward this end (such as specific topics and skills) vary considerably. Although many goals have been identified, they have not been developed into a complete curriculum. For this reason it is necessary to


consider computer literacy from the standpoint of curriculum development.

Curriculum Development

Curriculum theory. Theories underlying the field of curriculum and curriculum development are not clear cut and precise. Part of this is related to the wide variety of definitions of curriculum. Macdonald notes that definitions vary from ones like "the subject matter to be learned," which is quite narrow to broad definitions like "all the experiences students have in school." Macdonald also attributes part of this lack of precision and coherence to the existence of three major groups of theorists based on differing views of the purpose theory serves. The largest group of theorists believes curriculum theory provides a framework for developing and evaluating curriculum. This group sees curriculum theory as a practical, prescriptive guide. A second and smaller group follows the conventional view of scientific theory. The major concern here is with principles rather than practice of curriculum development. The theory generated by this group serves as a set of relationships and principles to be tested empirically. The third group of theorists rejects the purpose of the other two groups.

Instead, they provide analysis and develop theory as a means to stimulate new views of the curriculum. These theorists hope better ways of defining and developing curriculum will be generated as a result of their work.28

Prescriptive model. The prescriptive model of curriculum development is the most prevalent. Its roots lie in the production model advocated by Bobbitt in the 1920's. Bobbitt took a production management view of curriculum development, believing it was necessary to investigate society to identify knowledge, attitudes, and abilities needed by the individual. These then became objectives of the curriculum, and experience could be designed to produce desired student outcomes.

In his influential book, Basic Principles of Curriculum, published in 1949, Tyler proposed a theory of curriculum that was very much influenced by the Bobbitt tradition.29 Tyler's rationale for analyzing and developing curriculum is based on these questions:

1. What educational purposes should the school seek to attain?
2. How can learning experiences be selected which are likely to be useful in attaining these objectives?
3. How can learning experiences be organized for

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28Macdonald, pp. 5-6.

effectiveness of learning experiences be evaluated?  

Although Tyler noted that this book was not intended as a guide for writing curriculum because it did not "describe and outline in detail the steps to be taken... to build a curriculum," Tyler's rationale has become so widespread and respected that

...the few curriculum projects that have set their faces against it have done so with a deliberation and a concern to propound theoretical justifications which have marked very clearly their consciousness of departing from an established orthodoxy.  

Pragmatic approach. However, it is important to note there has been a persistent educational philosophy throughout the twentieth century that rejects the Bobbitt-Tyler view of objectives of education. John Dewey exemplified this. Regarding aims of education, he stated:

...ends arise and function within action. They are not, as current theories too often imply, things lying beyond activity at which the latter is directed. They are not strictly speaking ends or termini of action at all. They are terminals of deliberation, and so turning points in activity.  

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31 Tyler, p. 1.

32 Reid, p. 244.

This suggests a very different beginning point in curriculum development than was identified by Tyler. For Tyler the statement of objectives was the beginning of a curriculum, but for Dewey the learning activity itself was the beginning, with objectives arising from the activity to give it additional dimension.34

Dewey represented a movement in the philosophy of education based on science and scientific method. This movement was known by various names: "pragmatism," "instrumentalism," "experimentalism," "progressive education."

This philosophical movement was concerned largely with the nature of knowledge and its role in education.35 Dewey viewed thought as essentially an instrument used to solve problems. When an individual has a problem that is personally significant, he applies the process of reflective thought to solve the problem. The steps of reflective thought include:

1. Awareness of a need for a solution.
2. Clarification of the problem. The general awareness of and irritation with the problem is focused to examine the actual conditions and state the problem in terms that reflect it is capable of being solved.
3. Development of hypotheses. A number of tentative solutions are developed.


4. Projection of consequences. Each hypothesis is considered, the possible results are considered as fully as possible, and the best hypothesis is selected.

5. Testing of hypothesis. The selected hypothesis is implemented and examined to determine if it is a satisfactory solution.36

The source of curriculum content was examined by Dewey. He believed the two major schools of thought regarding curriculum content pitted student against curriculum. The disciplines school of thought identified the subject matter as more important; the student was merely the passive receptor of knowledge. From this viewpoint, the content and its organization determined curriculum. The child-centered school of thought saw the student and his development as the major focus of the curriculum; subject matter was important only in its ability to further the student's growth. Self-realization was perceived to be the aim of curriculum, and content was selected on that basis.37

Dewey felt both schools of thought operated on the fallacy that the curriculum had to be determined entirely by discipline or entirely by student interest. Rather, he saw the two sources as interacting. From the viewpoint of the student as source, he felt it was a matter of discovering the information, interests, attitudes and insights

36 Archambault, pp. xvi-svii.

gained in previous experience which were relevant to the subject matter at hand. From the viewpoint of discipline as source, it was a matter of viewing the discipline as a continuation of the student's previous experience and seeking means to build upon that experience to enrich understanding of the subject matter. Dewey clarified this interaction by describing how a teacher views subject matter:


...He is concerned with the subject-matter of the science as representing a given stage and phase of the development of experience. His problem is that of inducting a vital and personal experiencing. Hence, what concerns him as teacher, is the ways in which that subject may become a part of experience; what there is in the child's present that is usable with reference to it; how such elements are to be used; how his own knowledge of the subject-matter may assist in interpreting the child's needs and doings, and determine the medium in which the child should be placed in order that his growth may be properly directed. He is concerned, not with the subject-matter as such, but with the subject-matter as a related factor in a total and growing experience.

Thus, learning occurs as a result of interaction between student and content. Dewey's description of the conditions under which learning takes place is summarized by Frankena as follows:

1. The pupils must be engaged in activities or occupations.
2. These activities must involve physical action and be somewhat prolonged.
3. Each activity must involve a problem to be solved by thinking.
4. Activity must be carried out in cooperation with other pupils and the teacher.

5. Activities must be related to the normal interests of the pupils and within their capacities, though challenging them.

6. The atmosphere in the group must be free and as democratic as possible.

7. The whole experience of the activity must be "worthwhile in its own immediate having," but not just in the sense of being enjoyed, but in the sense of being good, not just good for something, but "good of itself." It must, however, also "promote having desirable future experiences," else it is not educative. 39

Although Dewey did not devise a rationale as specific and concrete as that of Tyler, his philosophy provides an alternative framework for curriculum development.

**STATEMENT OF PROBLEM**

Computers touch American lives in many ways, not only in society in general, but in the educational system. The need for schools to help students understand and use computers has been identified and referred to as a need for computer literacy. Although computers are used increasingly in education, many teachers do not know how to utilize them, and in some cases may be unwilling to use them. This problem is compounded by the lack of a clear definition of computer literacy for students. Thus, the skills needed by teachers are not easily identified. However,

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there still remains the mandate to prepare teachers sufficiently so they can work to ensure that students become computer literate.

STATEMENT OF OBJECTIVES

Purpose of Study

The central purpose of this study is to create a model for a curriculum in computer literacy for elementary school teachers. To this end, the various definitions of computer literacy for the five-year period of 1977-1981 are examined. Elementary school teachers' views of computer literacy, their attitudes toward computers in education, and their commitment to learning about computers are investigated. These research questions are considered:

1. Which of the topics and skills identified in the literature as components of computer literacy do teachers believe teachers need to know?
2. What are the teachers' attitudes toward computers in education?
3. How committed are teachers to increasing their knowledge of computers?

These questions are considered as means of determining guidelines for development of the curriculum.

SIGNIFICANCE

Rationale

Although most of contemporary curriculum has roots in the prescriptive model which was put forth by Tyler and
others, it is appropriate to explore other rationale for curriculum development. Dewey believed the purpose of education is to prepare the student for the life he will lead in the world. Therefore, his philosophy is a fitting guide for a computer literacy curriculum since much of the impetus for the curriculum arises from concerns that citizens must be familiar with computers to function in the modern world. Just as Dewey was concerned with the need for transition to an industrial society in his time, so are present educators concerned with the need for transition to a technological society. Thus Dewey's philosophy of education is applicable to the modern situation.

Relevance to Teachers

Because teachers are expected to assist students in the process of familiarization with computers, it is important to identify what teachers believe they themselves need to know about computers so the computer literacy curriculum for teachers is perceived as meaningful and useful. It is also vital to consider existing teacher attitudes toward technology and computers so that specific strategies can be developed which address these attitudes.

Curriculum Model

Although need for computer literacy is evident, a survey of the literature suggests that a curriculum model for elementary school teachers which utilizes microcomputers is not available. A wide range of activities and
objectives has been identified and some materials suggested, but a coherent curriculum for teachers has not been developed.

PROCEDURE

This study was accomplished in the following steps. The initial phase included a review of the literature regarding computers in education and an investigation of the writings of John Dewey to provide a philosophical rationale for curriculum development. Following the review of the literature, a survey was devised to measure attitudes toward computers, commitment to learning about computers, and computer related topics perceived to be important for teachers to know. This survey was administered to elementary school teachers during regularly scheduled faculty meetings in nine schools. Data from the survey were analyzed using the Statistical Package for the Social Sciences. Interpretation of the data served to guide the development of a computer literacy curriculum for elementary school teachers in the participating school district. Products of the study are 1) a computer literacy curriculum congruent with Dewey's philosophy and 2) a model by which other districts can develop similar curricula which would be responsive to the teachers in those districts.

Rationale

With Dewey's philosophy as a guide, it is clear
that the interests and attitudes of the student must be considered when attempting to devise a curriculum. For this reason, a survey of elementary school teachers was made to obtain these data. It is important to note that the data and their interpretation serve as means to an end. They allow the researcher to develop informed views about curriculum activities, content, and methods which are appropriate to the intended students, in this case elementary school teachers.

Population

The population was all elementary school teachers in Stockton Unified School District in Stockton, California.

Measuring Instrument

The instrument used was a survey with these categories of items: previous experience with computers; previous training in computer use; the computer literacy skills and topics identified in the review of the literature; attitudes toward computers and technology; and commitment to increasing knowledge of computers. A fixed alternative format was used to measure experience with computers, with an open-ended format for those with some experience to describe it. Likert-type scales were used for measuring attitudes and computer skills. A cumulative scale was used for measuring commitment to increasing knowledge.
Survey Procedures

The study included all elementary teachers in nine Stockton Unified School District schools. The total number of teachers at these schools was 196. Of those, 146 teachers completed the survey.

The survey required approximately ten minutes to complete. Time was made available during faculty meetings for teachers to fill out the surveys. Responses were confidential.

Data collection and interpretation was an important step in developing the curriculum model. With this information, curriculum aims based on local teacher attitudes and interests could be developed. This is vital to a curriculum based on Dewey's philosophy, since he believed curriculum aims must arise from variables unique to each situation. Therefore, interpretation of the data from a Deweyan perspective serves as a means for creating a curriculum that is unique and flexible.

SUMMARY

Computers have become pervasive in American society. Because of this, there has arisen the concern that individuals will not be prepared to cope with modern society unless they have some understanding of computers. Thus, the public schools face the growing expectation that they will provide students with some type of orientation to computers. On the whole, teachers are not prepared to
do this. Before the question of providing computer-related instruction for students can be addressed, teachers must become more knowledgeable. This study was undertaken to devise means of increasing teachers' knowledge of computers.
Chapter 2

REVIEW OF RELATED LITERATURE

Chapter 2 is organized in the following way. The first section addresses the topic of computers in education, examining administrative and instructional uses of computers and the computer literacy needs of teachers. The second section examines theoretical perspectives of innovation adoption. The final section develops a philosophical perspective for designing a computer literacy curriculum for teachers based on the philosophy of John Dewey.

Uses of Computers in Education

Two major areas of computer use in elementary education are found, administrative and instructional. Administrative use generally involves repetitive manipulation of large amounts of information related to personnel, materials, budget, students, curriculum, and facilities.  

Instructional applications utilize the computer as a teaching tool or as the topic of study.  


Administrative uses. A wide variety of non-student related administrative uses of computers are cited, all focusing on rapid and efficient processing of data. Computers are noted to be particularly useful in maintaining employee records and payrolls. Information about employees, including their rate of pay, hours worked, pay period, salary withholding, social security, retirement payments, and other items can be stored in a computer file and updated as necessary. Each pay period employees' salaries can be calculated and checks can be printed with both operations controlled by the computer. Other accounting and bookkeeping tasks such as inventories of fixed assets and expendable materials can be managed effectively with the aid of a computer, as can purchasing and expenditures. The ability of a computer to retain accurately and recall rapidly large amounts of information has led to many business oriented uses in education.

In addition, many student-related administrative applications are available. Poirot points out the feasibility of maintaining a student master file which holds data for every student. This could include all the basic information a district would wish to have, such as student name, address, telephone number, grade level, birth date, parent name and parent occupation. Rosters of students, bus schedules, and student directories can be generated from this.

Poirot, pp. 39-41.
data. Attendance records and grades can be stored, with report cards printed by the computer for each grading period. Scheduling of students is also facilitated greatly, since course requirements, class size, student course choices, and other factors can be considered rapidly and possible conflicts identified immediately. These student-related administrative applications are generally characterized by use of a computer to streamline and make more rapid tedious procedures formerly done on paper by hand.

**Instructional uses.** Computers are used in the elementary school learning process in two different ways, both as a learning tool and as a topic of instruction. As a learning tool, computers are used for two purposes, computer-assisted instruction (CAI) and computer-managed instruction (CMI). When students are taught about computers rather than with them, the result is generally referred to as computer literacy.

The most common form of CAI is drill and practice lessons, which are aimed at accomplishing specific learning as quickly and efficiently as possible. These programs

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4Poirot, p. 32.


take the student through repetitious exercises in which he practices a previously acquired skill. It is assumed that the student has already received instruction in the skill but requires practice to become proficient in its use.\footnote{John Fralick Rockart and Michael S. Scott Morton, Computers and the Learning Process in Higher Education (New York: McGraw-Hill, 1975), p. 85.}

Drill and practice programs can be extended to include some instructional material that is presented when the exercises are answered incorrectly, allowing the student to improve his understanding of the concept and skill immediately.\footnote{Alfred Bork and Stephen D. Franklin, "The Role of Personal Computer Systems in Education," Learning with Computers, ed. Alfred Bork (Bedford, Mass.: Digital Press, 1981), p. 16.}

A computer is particularly useful in this application because it can give feedback repeatedly without becoming bored or tired, as might a human instructor. It can generate numerous appropriate practice problems. It can monitor the student's performance to determine when a skill is mastered, or if the skill is not mastered, it can suggest resources the student can use to acquire the skill.\footnote{Bork and Franklin, pp. 15-16.}

A second common use of CAI is in tutorial lessons. Tutorials present material that has not been taught previously, with a primary purpose being student acquisition of new concepts. A simple tutorial generally consists of four steps: 1) identify the concept that is to be taught,
2) clarify and develop the concept through a series of statements, 3) increase comprehension by having the student restate the concept by working an example, filling in blanks in a statement, or demonstrating knowledge of the concept in some other way, and 4) make a logical transition to the next concept to be taught. As with drill and practice programs, tutorials can respond to student errors by branching to additional materials that give more help in mastering the concept. Unlike drill and practice, which merely reinforce a previously learned skill, tutorials are designed to take the place of the teacher in presenting material.10

Because a tutorial lesson is intended to take on the teaching role, these programs are more difficult to design than drill and practice. One basic premise of the tutorial is that the programmer can predict the student's responses and create appropriate material within the program for all possible responses. Thus, if a student's answer indicates the need for remediation, the program should be able to branch to the necessary material. However, this is an unrealistic expectation, so tutorials generally limit students to following the logic of the program designer. Because of this, tutorial instruction is most likely to be successful if the subject matter is fairly simple, well structured, and well understood by the program designer.

10 Rockart and Morton, pp. 84-85.
Although tutorials aim at creating teacher-student dialogue, in practice the program designer controls the interaction. Relatively little flexibility is allowed on the part of the student, since the student responds to questions with one of a limited number of alternative answers. Although tutorials encourage interaction, they must limit the role of the student because of the complexity of programming required.

A third instructional use of computers is simulations. Computer simulations create environments that are models of some part of the world. The student controls the model and can observe the impact of various factors on it. Simulations are used in a wide range of subject areas including social studies, economics, science and mathematics. They are often used to duplicate scientific experiments. The student manipulates a range of variables, including some that would actually exist in a laboratory as well as others that would be very difficult to make available in a laboratory. This allows students to experiment and attempt to generalize on the basis of what occurs in the controlled world. Social studies simulations explore the interaction of factors such as tourism, industrial development, pollution, population, and food supply with society. On a

11 Rockart and Morton, pp. 84-85.
12 Rockart and Morton, p. 103.
13 Bork and Franklin, p. 18.
smaller economic scale, one simulation called "Lemonade Stand" involves students in the business of making and selling lemonade. Decisions about price, quantity of lemonade produced, and advertising are made by students while various other factors like weather are randomly determined. Simulations are valuable learning tools since changes that occur too slowly or too rapidly to be seen easily can be reproduced at a different speed.

A fourth major instructional use of computers is as a problem solving tool. Two general approaches are possible; teaching a programming language or teaching the use of a preprogrammed software package. Both problem solving approaches use the computer in a markedly different way than do the other instructional applications. In utilizing the computer's problem solving capacity, the student directs the operation of the computer. This contrasts with the other CAI applications in which the programmer determines what the computer will do long before the student approaches the computer.

The most common programming language taught to students is BASIC, a simple language with relatively few concepts. Although some educators feel that BASIC has too

15Poiron, p. 11.
16Rockart and Morton, p. 11.
limited a vocabulary and is unwieldy for programming complex ideas, its popularity continues. Papert hypothesizes that this continued use of BASIC is explained by the simplicity of the language. He points out these probably causes of the continued use of BASIC:

BASIC is very unsophisticated and appears to be simple to learn and use.

Teachers are content with the limited success they attain when teaching BASIC.

BASIC is a well established language in the educational, publishing and computer manufacturing worlds, and so there is natural resistance to change.17

An alternative to BASIC, the LOGO language, was developed by Papert at the MIT Children's Lab. LOGO allows students to formulate solutions to problems in the form of computer programs.18 Children often begin with a turtle, either a small robotic device that moves along pieces of paper on the floor or a triangular light that moves on a display screen. Through LOGO commands the student directs the movement of the turtle as it draws lines. LOGO is particularly useful in teaching mathematics and geometric relationships, although applications in other content areas have been developed.19 Although LOGO was proposed as an

17 Papert, pp. 77-79. 18 Hartley, pp. 146-47.

alternative to BASIC, both languages are alike in that they can be used by the student to design computer programs to solve problems.

In addition to all of the above mentioned uses of the computer as a classroom instructional tool, the computer can also serve as a classroom management tool. In this computer-managed instruction capacity the computer helps the teacher cope with classes of students with varying achievement and ability levels while taking over some of the related paperwork burden.20 In addition to the computer hardware and software needed, CMI requires a curriculum with well defined specific objectives, a number of test items to measure each objective, and instructional materials which are cross-referenced to the objectives.21 Based on diagnostic test information for each student, group and individual learning plans are generated. Students with similar needs can be identified as a small group and instructional activities recommended for the group. Follow up testing is scored and recorded through the computer with each student's achievement monitored, new learning plans generated, and individual and group progress


reported. Through the management of instruction and paperwork, CMI is intended to free the teacher to do more work directly with students.

When the computer is used as a curriculum topic rather than as an instructional tool, the result is generally a course of instruction aimed at making students computer literate. Topics covered in these courses vary widely, but generally aim to teach the applications, limitations, and implications of computer use. Practice using a computer is usually included, with the computer often presented as a problem solving tool. These topics may be included:

- The history of computers
- Computer vocabulary
- The components of a computer system
- Problem solving with the computer
- Programming
- The limitations of the computer
- The potential threat of computers to society
- Computer related careers
- Computers and the future

A wide range of activities are included in computer literacy curricula for children. Some may be undertaken without a computer. For example, students can read about computers, learn to convert decimal numbers to binary numbers, and devise flowcharts for everyday activities.

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22 Watts, p. 20


require access to a computer, such as learning how to operate a computer, running programs written by others, and writing simple programs.25

Although there are a number of different ways to approach computer literacy for elementary school children, all are alike in their concern for providing an orientation to a society that increasingly uses computers. The Tri-County Goal Development Project devised an extensive delineation of the goals of computer literacy in the public schools. This project concludes that the general aim of computer literacy for students is the following.

Students will know and be able to apply computers in a fashion appropriate to their present and future personal, career, or educational level. 26

This statement underscores the growing conviction that computer literacy for students should become an integral part of the curriculum. Molnar represents this viewpoint rather dramatically by suggesting a parallel between computer literacy and reading literacy:

Computer literacy is a prerequisite to effective participation in an information society and as much a social obligation as reading literacy.27

Computer literacy for inservice teachers. The skills and knowledge teachers need to use computers effectively are


described as computer literacy. However, this term is used to describe a broad range of topics and objectives, and it should be noted that there is not consensus regarding the specific skills needed by teachers. This lack of agreement probably reflects the fact that computer use in education is relatively new and so the role of the teacher in this use is still unclarified. In addition, it appears to reflect the hierarchical nature of what is called computer literacy. Siedel identified three levels of computer literacy:
1) awareness of the impact of computers on present and future society, 2) knowledge of specific uses of computers in various disciplines, and 3) ability to write computer programs related to one's discipline. 28 Most descriptions of computer literacy for inservice teachers include at least two of these levels.

The literature on computer literacy for teachers yields a number of suggested topics for inservice education. The Association for Computing Machinery identifies teacher competencies needed to allow the integration of computers in schools. Their 1980 report lists the following as necessary for all teachers and administrators:

Be able to read and write simple programs that work correctly and to understand how programs and subprograms fit together into systems;

Have experience using educational application

software and documentation;

Have a working knowledge of computer terminology, particularly as it relates to hardware;

Know by example, particularly in using computers in education, some types of problems that are and some general types of problems that are not currently amenable to computer solution;

Be able to identify and use alternate sources of current information on computing as it relates to education;

Be able to discuss at the level of an intelligent layperson some of the history of computing, particularly as it relates to education;

Be able to discuss moral or human-impact issues of computing as they relate to societal use of computers generally, and educational use particularly;

Be able to use and evaluate the general capabilities of the computer as a tool for pursuing various discipline- or level-specific educational tasks;

Be able to use and evaluate alternative hardware and software systems designed to function as tutors or teacher aids;

Be familiar with alternative hardware and software systems designed to perform school administration;

Be familiar with information and quantitative techniques of studying one's subject.29

Another approach to computer literacy was developed by Northwest Regional Educational Laboratory. Their course is designed to introduce teachers and administrators to computers. The topics included in this course are:

Overview of hardware, software, and systems applications

Flowcharts and algorithms

29poirot, pp. 17-19.
This course is intended to briefly touch upon a wide range of topics.

Dennis approaches the question of inservice teacher training by devising three stages of training. The first, Initial Literacy Stage, is aimed at providing information about how computers facilitate instruction and how computer use can be integrated with other types of instruction. Dennis notes that actual experience using a computer and seeing instructional computer programs is vital at this phase. The second Implementing Stage involves having extensive experience using instructional programs prepared by others as well as learning how to write instructional programs. At the same time the teacher begins to use a computer in the classroom; application very quickly follows acquisition of computer expertise. The final and ongoing Maintenance of Growth Stage moves the teacher from tentative and incidental instruction with computers to commitment to

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establishing the computer as a vital part of the classroom. Also part of this last stage is a continual exploring of new information about computer uses in education so teachers can avoid expending energy and time devising programs and systems already available.\textsuperscript{31} This approach to computer literacy is unique in its suggestion to introduce computers in the classroom while the teacher is in the early stages of learning about computer uses.

The Minnesota Educational Computing Consortium (MECC) developed an extensive list of computer literacy objectives. These objectives were devised in conjunction with a research project investigating the instructional uses of computers in Minnesota schools, and reflect an attempt to operationalize the concept of computer literacy. Although these objectives are not specifically defined as those needed by elementary school teachers, they are valuable because they are very complete and precise. For the complete listing of the objectives, see Appendix B. The major topics included are 1) hardware, 2) programming and algorithms, 3) software and data processing, 4) applications, 5) impact, and 6) affective components.\textsuperscript{32}

Several textbooks aimed at teachers are available.

\textsuperscript{31}Richard Dennis, Teacher Education in Use of Computers, Education Resources Information Center, ERIC Document ED 183 181, 1979, p. 18-22.

\textsuperscript{32}David C. Johnson and others, "Computer Literacy - What Is It?" Mathematics Teacher, 73 (February, 1980), pp. 93-96.
In their textbook, *Computer Science for the Teacher*, Poirot and Groves include these topics:

- History of computers
- Hardware
- Binary mathematics, logic, and Boolean algebra
- Flowcharts and BASIC programming
- Instructional uses of computers
- Administrative uses of computers

The authors of this text designed it to be used with pre-service or inservice teachers with no previous experience with computers. A second textbook by Moursand is intended for elementary and middle school teachers. It focuses on information about hardware, software, and the impact of computers on education. The author does not include computer programming, although he notes that it would be desirable for teachers to learn some programming as well. He approaches his topics through study of:

- Computer technology and hardware
- Computer assisted instruction
- Educational games
- Data storage and management
- Problem solving

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Simulations

Artificial intelligence and futuristics

In summary, there is general agreement that teachers must be familiar with computers: this is described as a need for teacher computer literacy. However, an examination of the various topics included in suggested computer literacy courses indicates a lack of agreement on what information and skills teachers need. The entire range of possible topics may be summarized in the following categories:

HARDWARE

Terminology
Analog and digital computers
Components of a computer system
Criteria for hardware selection
Operation of hardware

SOFTWARE

Use of prepared software
Alternative software systems
Evaluation of software

PROGRAMMING

Flowcharts
Algorithms
Programming languages
Structured programming
BASIC
  Read simple programs
  Write simple programs
  Correct program errors
  Modify existing programs

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35 Moursand, *Introduction to Computers*, pp. 3-77.
Thus, the range of possible in-service topics for teacher computer literacy is very broad. However, making the transition from identifying possible topics to actually implementing a curriculum involves examination of other factors. It is important to consider factors that impede the curriculum.
Factors impeding computer literacy. In the early 1960's, predictions were made that computers would revolutionize education. In the twenty years since then, computers have become increasingly less expensive, more compact, more powerful, and more accessible. However, the computer revolution did not take place as predicted. This is believed related to educators' lack of knowledge of how to use computers for instructional purposes. This lack of computer knowledge can be examined from two standpoints. The first approach is to identify specific factors that impede teachers' knowledge of computers. The second approach is to examine the theory of adoption of innovations to develop a broader perspective of the current situation of computers in education. The next section investigates specific factors contributing to a lack of computer literacy among teachers.

Two general categories of factors have been identified as impeding acquisition of computer literacy. These are 1) teachers' attitudes toward and beliefs about computers and 2) lack of opportunity for teachers to learn.

Many attitudes and beliefs are cited as causes for inadequate knowledge of computers. Molnar suggests that the major source of this resistance is fear. Since many people are afraid of technology, some teachers are afraid of

This fear may be manifested as a reluctance to think or talk about computers, or as anxiety, hostility and aggressions. Jay identifies these as indicative of this fear of computers:

- Reluctance to touch a computer.
- Concern that contact with it could damage the computer.
- Denial of computers by avoiding reading or talking about them.
- Belief that students or others who know about computers are a threat.
- Feelings of dehumanization.
- Desire to damage or thwart the computer.
- Belief that the individual is controlled by the computer rather than controlling the computer. 38

Another teacher attitude identified as an impediment to learning is a reluctance to embark upon an entirely new area of study, particularly if the teacher questions the relevance of computers in the curriculum. Even if the teacher believes computers are appropriate educational tools, he may hesitate to plunge into the new discipline. 39

Thus feelings of fear and reluctance are linked to teachers' lack of computer knowledge.


Knowledge of computers is often identified with knowledge of mathematics. This is evident from the inclusion of computer literacy as a goal in the National Council of Supervisors of Mathematics position paper on essential mathematical skills. Results of several research projects indicate that those teachers who know about computers and are among the first to use them are almost always involved in the areas of mathematics and science. Because computer literacy is often considered a part of the mathematics curriculum, use of computers is seen as related to skill in mathematics. As a result, teachers who lack training in mathematics might anticipate having difficulty learning to use computers.

In addition, many teachers express concerns about the impact of computers on education. They anticipate that computers will bring about changes and question the results of their use. They focus on these questions:

- Will computers take over the teacher's job or radically change the role of the teacher?
- Will computers create a depersonalized learning environment?
- Will students become too dependent on computers by allowing the computer to do their thinking?
- Are computers just a fad, much like educational television?

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40Johnson and others, p. 91.
41Edwards, p. 20; Loop and Christensen, p. 17.
Will education become too standardized if schools rely heavily on computers?

Will computers make classrooms harder to discipline and control?

Will computers waste time by requiring excessive preparation time?

Aren't computers mainly useful only for increasing recall?  

These questions probably reflect two types of attitudes: that of teachers who do not want to learn about computers and justify their reluctance with these concerns, and that of teachers who are cautious about educational changes and would like reassurance about the effects of computers before they commit themselves to learning. In either case, attitudes and beliefs appear related to lack of computer knowledge.

In addition, teachers have very few opportunities to learn about computers. At joint hearings in 1980 before subcommittees of the Committee on Science and Technology and the Committee on Education and Labor, Littman pointed out that many teachers completed their training before computers were

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readily available in education. He told the House of Representatives:

... how are we to provide the necessary training and retraining of teachers of elementary and secondary schools to permit them to understand and use the new available technologies? This sudden explosion of learning technology has left the majority of teachers in the schools with little knowledge and/or experience with the new technologies. During the formal learning periods of the majority of teachers these modern information technologies did not exist and no effort has been made to bring this knowledge to them. 43

Very few universities and colleges offer courses in computer science for teachers and prospective teachers. This situation is changing, but at present many schools of education have not yet implemented courses of study focusing on computers in education. Among those that currently have such courses of study are Teachers College, Columbia, the University of Illinois, Stanford University, and the University of Oregon. However, the majority of teachers do not have access to courses that are integrated into a program and that are concerned with the use of computers in particular disciplines or teaching areas. 44

Thus, two major factors that impede computer knowledge have been identified. Teachers may have attitudes and beliefs that discourage them from learning about computers. This situation is compounded by a lack of


44 Milner, p. 545.
opportunity to receive instruction about computers. While an understanding of these factors is useful in gaining a perspective on the immediate situation of computers in educations, a broader view of innovations is desirable. This broader view is found by examining theoretical perspectives of innovation and change. The next section addresses this topic.

Adoption of Innovations

Many theories have been formulated to explain and describe change in systems, organizations and individuals. The theories may be viewed as falling into two categories, 1) internal change models, those that view change as arising mainly from within organizations or individuals and 2) external change models, those that suggest change originates in the environment or in social conditions. 45

Internal change models. Internal change models identify the source of change as being within the organization. Impetus for change lies in dissatisfaction with an existing procedure and the resulting desire for a new procedure. This awareness of a gap between the actual and the desirable prompts investigation of new means of accomplishing goals. 46

These new means are innovations:

An innovation is an idea, practice, or object perceived as new by an individual. An innovation might be known by an individual for some time (that is, he is aware of the idea), but he has not yet developed a favorable or unfavorable attitude toward it, nor has he adopted or rejected it. The "newness" aspect of an innovation may be expressed in knowledge, in attitude, or regarding a decision to use it.47

It is important to note than an innovation is not necessarily a newly created concept or object, but that it is new to the individual in some sense.

It is often suggested that awareness of a problem is the incentive for adoption of innovative ideas. While it is true that a problem does lead to a search for solutions, it is not only under this condition that innovative ideas arise.

... The stream of innovative ideas into and through the organization exists independent of problems. Ideas may be brought into the organization by new personnel. ... Organization members may be attracted to certain ideas and push these ideas for adoption. Attraction to an idea may cause the member to look for a problem to which the innovation can be attached as a solution, or the participant may present the idea as an opportunity for improved organizational performance.48

According to the internal change model, then, innovative ideas may be adopted under one of these conditions: a problem is identified and solutions are sought, or an innovation is known and considered attractive, so applications of it are suggested.


48Daft and Becker, p. 10.
Daft and Becker identify two major steps in the process of deciding to innovate. The first step occurs when a participant suggests an innovative idea or perceives how the idea may be related to a problem, and then requests approval for the innovation. The second step involves the formal choice opportunity in which a selection is made from among several opportunities. Daft and Becker emphasize that it is necessary to have an innovative idea and the expectation that a decision will be made, but it is not necessary to have identified an urgent problem. They present a schema of their view of the basic sequence of innovations. Figure 1 illustrates this schema. It is clear from the schema that this internal change model does not deny influence of the external environment on the change process. However, the major force in adopting innovation is seen as within the organization itself rather than outside it.

Rogers and Shoemaker have devised an extensive internal change model of the innovation process. They identify the major factors of it as:

. . . (1) the innovation (2) which is communicated through certain channels (3) over time (4) among the members of a social system.

Each of the four major factors is important in the adoption of innovations. Each of the factors is examined in the following paragraphs.

49Daft and Becker, p. 10.

50Daft and Becker, p. 160.
INTERNAL CHANGE MODEL*

1. Change in structure and/or function of external environment
   - Performance gap
   - Innovation
   - Felt need to change structure and/or functioning of the organization
   - Persuading others that change is needed
   - Search for solution; use existing solution or develop new
   - Identification of most appropriate solution

2. Change in organization
   - Continued implementation or rejection of most appropriate solution
   - Adopt most appropriate solution
   - Decision making: collective authority
   - Reject most appropriate solution

*Daft and Becker, pp. 132-33.
There are a number of characteristics of innovations that affect the rate of adoption. Rogers and Shoemaker identify these characteristics as the following.

Relative advantage. The more advantageous an innovation appears, the more rapidly it will be adopted. There are several ways in which an innovation may be seen as advantageous; it may seem to be more economical, convenient, prestigious, or satisfying. This does not mean the innovation actually is more advantageous, but it is perceived to be so.

Compatibility. The more compatible with the values, needs and past experiences of the user, the faster an innovation will be adopted.

Complexity. The easier an innovation is to understand, the more readily it will be adopted. If an innovation requires learning new skills and ideas to use it, it will be more slowly adopted than one requiring little additional learning.

Trialability. If an innovation can be tried on an experimental basis, it is more likely to be adopted. An innovation that can be tested on a trial basis is less risky to the user.

Observability. The more easily the results of an innovation can be seen, the more likely it is to be adopted.\(^5^1\)

Thus, some characteristics of the innovation, as perceived by the potential user, may increase the chances that an innovation will be adopted and influence the rate at which it is adopted.

The second major factor considered is communication channels. Communication is the transmission of ideas from some source to another with the purpose of changing the behavior of the receiver. Means by which the message is communicated is the channel. Two kinds of channels are

\(^{51}\text{Rogers and Shoemaker, pp. 22-23.}\)
available, mass media and interpersonal. Mass media is an effective way to communicate information about a new idea. However, if the purpose of the communication is to persuade the receiver to have a favorable attitude toward innovation, interpersonal communication is more effective. The communication channel selected is determined by the receiver's stage in the innovation-decision process.\textsuperscript{52} This process is explained in the next paragraph.

Time is the third major factor. Various time factors may affect change in a number of ways. Rogers and Shoemaker identify three separate time dimensions involved, 1) the innovation-decision process, 2) the degree of innovation of the individual and 3) the innovation's rate of adoption in the social system. To elaborate, the innovation-decision process is the mental process an individual goes through from first learning about an innovation to finally deciding to reject or adopt it. There are four major steps in the process:

1. Knowledge. The individual gets some information about the innovation and how it works.
2. Persuasion. The individual develops a favorable or unfavorable attitude toward the innovation.
3. Decision. The individual engages in behavior that leads to a decision to adopt or reject the innovation.
4. Confirmation. The individual searches for reinforcement of his decision. The decision may be changed if new, conflicting information is

\textsuperscript{52}Rogers and Shoemaker, p. 18.
The second time factor found by Rogers and Shoemaker is the innovativeness of the individual, since people adopt new ideas at varying speeds. Five general categories have been identified:

1. Innovators. Individuals in this category are venturesome and prepared to try out new ideas. Innovators have a cosmopolitan viewpoint rather than a local viewpoint.

2. Early adopters. Individuals in this category have many of the same characteristics as the innovators, but are a part of a local system. They are opinion leaders in their own social systems.

3. Early majority. Individuals in this category are just a little faster than average at adopting innovations. They tend to spend a longer time making the innovation decision and are willing to follow another's lead in adopting new ideas.

4. Late majority. These individuals tend to adopt an innovation a little later than average. They tend to be cautious and skeptical, and do not adopt innovations until most of their peers already have.

5. Laggards. These individuals are suspicious of change and of those who attempt to innovate. They tend to be traditional and look to past experience for guidance. The innovation-decision process is very long, with the decision step following long after the knowledge step.

These categories of individuals are not discrete, but should be viewed as on a continuum. Individuals may not fit precisely in any one of them.

The third and final time factor is identified as the

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54Rogers and Shoemaker, pp. 183-85.
rate of adoption by the social system, the group in which
the individual functions. The social system is:

... a collectivity of units which are functionally
differentiated and engaged in joint problem solving
with respect to a common goal. The members or units
of a social system may be individuals, informal
groups, complex organizations, or subsystems. 55

Social systems adopt innovations at varying rates, due to
effects of the system that facilitate or impede innovation
adoption. These system effects are the influence the social
system has on the individual. In general social systems
categorized as modern adopt innovations more rapidly than
those classified as traditional. 56

Rogers and Shoemaker devised a description of modern
and traditional social systems. These two types of social
systems may be viewed as the extreme ends of a continuum,
with many social systems falling somewhere between. This
description is important because modern and traditional
social systems react differently to innovation. Traditional
social systems exhibit these characteristics:

Lack of favorable orientation to change.
A less developed or "simpler" technology.
A relatively low level of literacy, education, and
understanding of the scientific method.
A social enforcement of the status quo in the social
relationships, such as friendliness and hospitality,
which are highly valued as ends in themselves.
Little communication by members of the social system

55 Rogers and Shoemaker, pp. 28-29.
56 Rogers and Shoemaker, pp. 27-29.
with outsiders. Lack of transporation facilities and communication with the larger society reinforces the tendency of individuals in a traditional system to remain relatively isolated.

Lack of ability to empathize or to see oneself in others' roles, particularly the roles of outsiders to the system. An individual member in a system with traditional norms is not likely to recognize or learn new social relationships involving himself; he usually plays only one role and never learns others. 57

In contrast, the modern social system is characterized by the following:

A generally positive attitude toward change.

A well developed technology with a complex division of labor.

A high value on education and science.

Rational and businesslike social relationships rather than emotional and affective.

Cosmopolite perspectives, in that members of the system often interact with outsiders, facilitating the entrance of new ideas into the social system.

Empathic ability on the part of the system's members, who are able to see themselves in roles quite different from their own. 58

In general social systems that have modern characteristics are more likely to accept change while traditional social systems are less likely to accept it. However, it should be noted that most social systems fall somewhere between the two extremes of modern and traditional.

The internal change model focuses attention on the social system and the individuals within it. Proponents of

57Rogers and Shoemaker, pp. 31-32.

58Rogers and Shoemaker, pp. 27-29.
this model hypothesize that the most important factors determining whether an innovation is adopted are 1) the existence of innovative ideas that could be implemented, 2) some incentives to innovate and 3) a social system that is amenable to change and implementation of innovations.\(^5^9\)

**External change models.** External change models identify innovations as originating in changes in the environment or social conditions. It is assumed that individual or organizational change must be preceded by changes in the larger social conditions. Levin's polity model exemplifies the external change models.\(^6^0\)

Levin identifies the polity, or organized society, as the most important factor in educational change. He states this very strongly, saying:

... the educational system corresponds to the social, economic, and political institutions of our society and... the only way we can obtain significant changes in educational functions and relations is to forge changes in the overall social, economic, and political relationships that characterize the polity.\(^6^1\)

He points out that the purpose of schools is to prepare children for roles they will fill as adults in society. Thus, the actual purpose of schools is best judged by how

\(^{5^9}\)Daft and Becker, p. 15.

\(^{6^0}\)Zaltman and others, pp. 52-54.

this task is accomplished and what the outcome of schooling is, rather than by the rhetoric surrounding the educational process. For example, the stated purpose of education may be to provide equal opportunities for all students. However, if an examination of the procedures and outcomes of the school system indicates that children of different economic classes receive different opportunities, then the actual purpose of schooling is not congruent with the stated purpose. In this way, schools are socially functional.62

Levin presents a schema to illustrate the relationship between the educational system, external influences of education, and educational reform. His schema is illustrated in Figure 2. It is discussed below.

The focus of Levin's theory is the polity. He defines this as organized society, including its government and political ideology. The polity expects citizens to go through some sort of socialization so that the existing culture and social, political and economic order will be valued and maintained. These expectations are expressed in laws that govern the schools. In addition, the polity affects education through the expectations that individual citizens have for their role in society and the education they need to fulfill these roles. Thus, the polity affects education in two ways; through formal government policies and through the values, attitudes, and expectations of the individuals

Figure 2

EXTERNAL CHANGE MODEL*

*Levin, p. 31.
who are citizens of the polity.  

The polity exerts influence on the educational sector by determining goals and budgets. Goals are expressed in laws that require school attendance, set the licensing requirements for school personnel, mandate curriculum and the like. Budgets allocate the amount of money the polity wishes to be spent on education. Generally the budget allocations are determined by factors outside the schools in which the money will be spent. The expectations society has for the schools are enforced through regulations and through control of monies.

Most of the decisions about what educational resources will be financed by the budget are determined by the polity. One major educational resource is the personnel. Levin states that, in general, educational personnel are hired less for their skills than for their values. The system of certification, training, and hiring guarantees educational personnel who are socialized in the best interests of the polity.

Levin also identifies ways the polity influences the educational process. The educational setting and the means of education are set in a fairly inflexible pattern. That is, the hierarchy of personnel, content of curriculum, acceptable learning activities, definitions of academic success

63 Levin, pp. 30-33.  
64 Levin, pp. 33-34.  
65 Levin, pp. 34-35.
and failure, and the like are all determined for any given child long before the child himself is presented for educating. Although individual instruction is identified as a means for adapting the educational process to the individual, very little effort is made to implement it. By maintaining a fairly rigid structure, the main purpose of education, which Levin identifies as socialization of the individual, is not lost or subverted.

Although cognitive goals are most easily identified, the educational system also has as goals the values and personality characteristics that are necessary for individuals to fulfill their roles in society. Thus, the educational system seeks to inculcate political attitudes, moral values and attitudes toward work that are perceived by the polity as necessary for a stable society. In this way the polity sets the goals for education.

Levin points out that schools are also involved in social, political, and economic outcomes. Schools serve to produce adults who will be able to take on necessary roles that sustain the polity. Thus the schools transmit values and acculturate the individual, ensuring the continuing and future existence of the society. The end product of the schools can be seen as the effect the individuals have on maintaining society, the political system, and the economy.

66Levin, pp. 35-36.  
67Levin, pp. 36-37.  
68Levin, pp. 37-38.
Because of this, the polity cannot afford to allow the educational system to function unmonitored and undirected.

Even though the purpose of the schools is to maintain the existing social order, Levin emphasizes that change occurs only under certain conditions. Thus, change is not a result of educational policy but rather of a change in the polity. Levin cites two major ways in which the polity may change. The first is change induced by factors outside the control of the polity, such as natural disasters, importation of technology, emigration or immigration, wars, and similar factors that come from external forces. These may have a significant impact on the organization, values, and structure of a social system. The second major source of change comes from internal contradictions in the polity. These contradictions arise from unanticipated consequences. For example, Levin points out:

... changes in technology that are created for one purpose may have unanticipated consequences which affect profoundly the society and force it to comply with a new set of conditions. 69

The contradictions which arise must be eliminated in order to maintain the social order, so the polity adapts to them.

In his external change model, Levin contends that the educational system changes only when a contradiction has arisen and the social system has adjusted to it. Only then does the educational system change to fit this adjustment.

69 Levin, p. 39.
Thus change in the society requires the educational system to make parallel change in order to remain functional. Attempts to reform educational process without the existence of social, economic or political contradictions are, in Levin's view, unsuccessful. Changes in education do not precede, but rather follow, changes in society.  

The polity model has some specific implications for education. Zaltman and others identify these:

Innovations must be presented in a way that appears consistent with the goals and values of the larger society.

Innovations should be introduced when the larger society is experiencing significant changes.

Innovations that change the product of the educational process have to reflect some change in needs of the larger society.

Summary of theoretical perspectives. There are two major theoretical perspectives on change and innovation in education. The first, the internal change model, identifies change as arising from within the educational system. The source of change is the perception of a gap between what is being accomplished and what is wished to be accomplished. Thus a solution is sought and change is effected. The second perspective, the external change model, is based on the premise that the educational system exists for the purpose of maintaining social order. The only condition under which

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70 Levin, pp. 38-42.

71 Zaltman and others, pp. 54-55.
education can change is if the society itself changes and requires that the educational system make a corresponding change. While these two perspectives are not diametrically opposed, they do provide alternative views on adoption of innovations, sources of change, and conditions necessary to allow change. Taking both perspectives together, they suggest that to have change in education, one of these conditions must exist:

- Perception and acknowledgement of a problem and a subsequent search for the best solution.
- Awareness and knowledge of an innovation, desire to use it, efforts to identify possible uses of it, and efforts to convince others to adopt it.
- Redefinition by society of necessary adult competencies and a corresponding change in the educational system to provide these competencies.

However, even if one of these conditions does exist, change will not necessarily occur rapidly. As pointed out in the discussion above, a number of other factors influence the rate of adoption of innovation.

**Factors impeding adoption of innovation.** A tremendously wide range of factors that impede educational innovations have been identified. Many authors have categorized these factors in a variety of ways. For example, cultural barriers, social barriers, organizational barriers, psychological barriers, personal attitudes, and attributes of the innovation have all been proposed as categories of factors that impede innovation. While these headings are useful and valid, these same factors can also be viewed as reflecting
the absence of one of the three conditions necessary for educational innovation noted above. That is, factors which impede innovation can be viewed as reflecting one of these negative conditions:

No problem has been identified or acknowledged. The innovation is rejected because it is not perceived as needed.

A problem has been acknowledged, and solutions sought. However, the innovation is not perceived to be the best solution.

There is little or no knowledge of the innovation, so uses of it are not sought.

Some individuals have knowledge of the innovation, perceive uses of it, but have not convinced others to adopt the innovation.

The expectations of society of what the educational system should produce have not changed to require the innovation. There is no need for the innovation, so educational resources have not been allocated to implement it.

The first question to consider is whether a problem has been identified that demands the use of computers in education. It is clear that there are many potential uses of computers in education, but of the uses cited in the first section of this chapter (management applications and instructional applications, including CAI, CMI, and computer literacy) all but computer literacy instruction involve using the computer to complete tasks which are currently performed in the normal non-computer school setting. Although use of the computer would facilitate these tasks, a computer is not necessary. Computer literacy would require computer use, but as researchers point out in a MECC report:
While universal agreement on the need to educate all students about computers and computer uses has not been reached, a growing number of educators believe that all students should be provided with educational opportunities which will allow them to become computer literate.\textsuperscript{72}

This makes it clear that at present there is no general identification of computer literacy as a pressing need, so lack of computers in education is not seen as a problem in itself.

The second question is whether a problem has been identified and the use of computers rejected as the best solution. This does not appear to be true. In fact, review of the literature indicates that the question of solving a particular educational problem with computers is not the approach taken. Rather, numerous possible uses of computers in schools are identified and described.\textsuperscript{73} These uses are intended to streamline existing practices which perhaps are time consuming and cumbersome, but are not perceived as actual problems.

The third and fourth questions examined together are related to whether an innovation has not been adopted because individuals in the system do not know about it. It does appear that relatively few teachers are familiar enough with computers to use them. The majority of teachers seems unable to make decisions about using computers because they know

\textsuperscript{72}A Study of Computer Use and Literacy (St. Paul: MECC, 2980), p. 1.

\textsuperscript{73}Watts, p. 18-21.
very little about them. 74

The final question is related to whether the societal expectations for adult competencies have changed to require computer knowledge. As noted in a MECC study, there is at present no general agreement that all individuals need to know about computers and their use. 75 Although there have been strong calls for universal computer literacy, 76 it appears that at present there is no societal expectation that all students will learn about computers.

A Philosophical Approach

John Dewey addressed much of his writing to the education of children rather than adults. In spite of this, many aspects of his educational philosophy can be used to develop a computer literacy curriculum for teachers. The continuing relevance of Dewey's philosophy to current education is suggested in this quote:

Just as the use of laboratories was an important innovation in American education in the times of John Dewey, the use of the computer in schools will be the laboratory innovation of the future—if not of the present. 77

74 Earl L. Keyser, "The Integration of Microcomputers into the Classroom," AEDS Journal, 13 (Fall, 1979), pp. 113-14.

75 A Study of Computer Use and Literacy, p. 1.


Dewey was a prolific writer, commenting on a wide range of topics and issues related to education. For the purposes of this study, these aspects of his writings are considered:

1. Education and social change
2. The inquiry model of education
3. Aims and goals in education
4. Experience

Education and social change. Dewey believed that education changes to reflect changes in society, but that schools also change society. In describing the way in which the schools respond to social changes, Dewey wrote:

"The modification going on in the method and curriculum of education is as much a product of the changed social situation, as much an effort to meet the needs of the new society that is forming, as are changes in modes of industry and commerce. . . . Let us then ask after the main aspects of the social movement; and afterward turn to the schools to find what witness it gives of effort to put itself in line." 78

Thus Dewey saw educational changes as tied to social changes.

However, Dewey also stressed the fact that education in turn influences society. He characterized education as "the fundamental method of social progress and reform." 79

While he did not suggest that education alone could be used to create a new social order, he did emphasize that schools...
necessarily have an effect on society because they encourage particular attitudes and achievements. He believed educators should recognize the influence schools have on future society and encourage social consciousness and responsibility. He saw schools influencing society in this way:

... we may produce in schools a projection in type of the society we should like to realize, and by forming minds in accord with it gradually modify the larger and more recalcitrant features of adult society.  

To summarize, Dewey saw educational change as arising in response to social change; in return schools influence society through dispositions fostered in the students.

**The inquiry model.** Dewey based this model of education on the scientific method of inquiry. He believed education should systematically train students to think logically and deliberately in a manner he described as reflective thinking. Reflective thinking is problem solving.  

The individual, in solving a problem that is significant to him, follows these steps:

1. Awareness of a difficulty or need.
2. Clarification and formalization of the problem. The general awareness of and irritation with the problem is focused to examine the actual conditions. The problem is restated in terms that reflect that it is capable of being solved.

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3. Identification of possible solutions. Hypotheses are developed and compared.

4. Evaluation of each solution. Each hypothesis is considered carefully and consequences are projected. The validity and implications of each are examined.

5. Testing the selected hypothesis. One hypothesis is accepted and implemented. Implementation may be real or imaginative. The idea is verified.82

It is important to note that Dewey viewed the real purpose of reflective thinking not merely as finding the best solution to a given problem, but also as development of a methodology of thought.83

This methodology also entails the development of certain personal characteristics. Besides just implementing the steps of reflective thinking, the individual must become less impulsive and more deliberate. He must be willing to postpone action, to cultivate his sense of inquiry, and to learn all information relevant to the problem. He must also learn to act intelligently on the outcome of his reflection, to implement solutions patiently, persistently, and well.84

Reflective thinking, then, is more than just a problem solving approach. According to Dewey, it is the habit of intelligence.85

82 Archambault, pp. xvi-svii.
83 Doll, p. 63.
84 Frankena, p. 144.
Education aims and goals. Dewey objected to the two opposite and extreme views of how educational aims may be determined. Some educators hold that the student himself determines educational activities. These child-centered teachers tend to surround the student with tools and materials, offer no suggestions or plans, but let him use them as he wants. Dewey rejected this approach, saying:

Now such a method is really stupid. For it attempts the impossible, which is always stupid. . . . There are a multitude of ways of reacting to surrounding conditions, and without some guidance from experience these reactions are sure to be casual, sporadic, and ultimately fatiguing. 86

He pointed out that students cannot determine alone what they should do. Since they know so little their suggestions are very likely to be superficial and their activities to be pointless.

Likewise, he rejected the approach that outlines clearly all the expected and desired educational outcomes. This approach encourages the teacher and student to be blind to all but that which is anticipated. Dewey suggested this desire to define outcomes is a result of sloppy, lazy thinking and resistance to change. Having fixed outcomes keeps the individual from taking responsibility for the outcomes, relieves him of the need to examine consequences of his actions, and also allows him to avoid a careful examination

of what is around him. Dewey summarized:

Love of certainty is a demand for guarantees in advance of action. Ignoring the fact that truth can be bought only by the adventure of experiment, dogmatism turns truth into an insurance company. Fixed ends upon one side and fixed "principles"—that is, authoritative rules—on the other, are props for a feeling of safety, the refuge of the timid and the means by which the bold prey upon the timid.

In rejecting educational approaches that refuse to determine any aims and those that define all aims, Dewey took a position that defined aims as:

...acceptance of responsibility for the observations, anticipations, and arrangements required in carrying on a function.

Dewey rejected the notion that aims should be imposed on education from an outside agency, such as a church or government. He also rejected the idea that aims could be fixed. Frankena points out that, in fact, Dewey often wrote as if education has no end except more education. In spite of this apparent denial of any general aims of education, Frankena garners from Dewey's writing these aims of education: to develop and free the potential of the individual, and to bring about a better society. Within the framework of these larger aims, Dewey believed more specific ends should

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90 Frankena, p. 154-56.
be determined by activities and needs of the individual to be educated.\textsuperscript{91}

To clarify his view of educational aims, Dewey described how an aim is formed. The process begins in dissatisfaction with the present situation and a desire for something different. The mental picture that grows to illustrate the improved, idealized situation only becomes an aim when concrete means are identified to implement it. Past experiences are examined to find patterns of cause of effect, and this knowledge is applied to the present situation to find some means of effecting change. This process of identifying means is similar to that of the inquiry model.\textsuperscript{92}

Dewey elaborated on his idea of aims in education by citing the characteristics of good aims. A good aim is one that:

Grows out of an existing situation which has been carefully examined and is well understood.

Is based on the activities and needs of the individual who is to be educated.

Is flexible and can be revised as necessary.

Displays intrinsic continuity; consists of orderly and ordered activities; contains a process that is progressively completed.

Has a foreseen end.

Is achieved through appropriate means but is not perceived to consist only of its activities; the aim is

\textsuperscript{91}Dewey, Democracy and Education, p. 121.

\textsuperscript{92}Dewey, "The Nature of Aims," p. 78.
not confused with the activity.\textsuperscript{93}

In sum, Dewey pointed out that a good aim:

... surveys the present state of experience of pupils, and forming a tentative plan of treatment, keeps the plan constantly in view and yet modifies it as conditions develop.\textsuperscript{94}

In rejecting the two extreme ways of dealing with curricular aims, that of selecting no aims and that of selecting all aims, Dewey took a moderate approach. He believed aims should be set but that they should be flexible to accommodate the learner.

\textbf{Experience}. Dewey stated that all learning takes place through experience. However, activity alone is not experience. Experience involves change, consequences of change, and conscious reflection on and understanding of the relation between the change and its consequence. In Dewey's view, experience has two aspects, active and passive. In the active sense, experience is "trying;" in the passive sense it is "undergoing." When the learner experiences something, he first acts upon it, and then it acts upon him in the form of consequences of the experience. The learning value of the experience can be measured by the extent to which the individual perceives the relationship between the act and its consequences. By way of illustration, Dewey cited the case of a child putting his finger in a flame. If

\textsuperscript{93}Dewey, \textit{Democracy and Education}, p. 118-20.

\textsuperscript{94}Dewey, \textit{Democracy and Education}, p. 123.
the child understands that the pain is a result of his action, then he has experienced the act and has learned. If, however, he does not realize that the pain was caused by putting his finger in the flame, then this act has not been an experience in Dewey's terms.95

Dewey's notion of experience brings together body and mind in learning. He pointed out that this contrasts with many approaches that consider only the mind important, and further argued that this separation of mind and body is very harmful. He cited these factors for his opposition to this separation:

The body is not considered important so it becomes a distraction to be overcome. Effort is made to suppress the body and to reduce its activity as much as possible.

The acceptable uses of the body, such as seeing, hearing, speaking, and writing involve training the body in a mechanical way rather than in a way that facilitates understanding. By way of example, Dewey noted that children who learn to read in a very mechanical way, identifying letters and reproducing sounds, often have difficulty reading aloud in expressive, meaningful ways. The mechanics of reading are divorced from the meaning of the words.

More emphasis is put on separate objects and ideas than on relations and connections between things.96

Dewey suggested this dualism could be avoided by including the body in learning instead of ignoring it. He believed this was essential, as all learning occurs as a result of activity. Thus, successful instruction must give the student

95Dewey, Democracy and Education, p. 163.
96Dewey, Democracy and Education, pp. 164-68.
something to do rather than something to learn. The basis of instruction must be concrete experiences that involve both mind and body of the learner.

Implications of Dewey's philosophy. A number of implications of Dewey's philosophy of education can be identified. Doll states the major curriculum implication is that the primary aim of education should be the development of the thought process, with less emphasis placed on the product of education. He points out the impact this has:

This emphasis in turn, means a personal involvement in the choosing of ends, experiencing of consequences, and development of alternatives not found in most curriculum or behavior models.

This suggests that the major purpose of a computer literacy curriculum is to enable teachers to apply the inquiry model of thinking to the subject of computers in education.

The curriculum must be flexible and responsive to learners. Teachers must be involved in determination of aims of the computer literacy curriculum. Specific aims arise from the teachers and their existing situation, but must remain flexible. The curriculum must include a method of periodic reconsideration of aims to determine if they remain valid or if they should be modified. Although the major purpose of the curriculum would remain the same, the curriculum must be flexible enough to allow for changes in shorter term aims and activities provided to attain them.

98 Doll, p. 68.
Thus it becomes clear that the computer literacy curriculum cannot be prepared in total detail in advance. The overall purpose can be determined, preliminary aims can be set by conferring with teachers prior to implementation, and activities to achieve aims can be devised, but this form of the curriculum is not final.

Aims of the curriculum are achieved first through activity and then through reflection on the activity. Activities are devised which address the aims and are followed with an opportunity to reflect on the activity. Reflection may be accommodated through written work or discussions of the experience. New curriculum aims may arise as a result of reflection. Thus, the structure of the experience includes first an activity, then a thoughtful reconsideration of the activity, followed by an opportunity to redirect the curriculum by identifying new aims.

Summary

Chapter 2 has examined three major topics. The first was the present state of computers in education and the call for computer literacy for teachers. Factors that impede computer use and teacher computer literacy were examined. The second topic examined was that of theoretical perspectives on change and innovation in education. The question of computers in education and teacher computer literacy were discussed in relation to these theoretical perspectives. The final topic addressed the educational
philosophy of John Dewey and its applicability in developing a curriculum for computer literacy for teachers. Implications of Dewey's philosophy on this curriculum were identified.
Chapter 3

PROCEDURES

The major purpose of this study was to design a computer literacy curriculum for elementary school teachers. The philosophical perspective developed in Chapter 2 indicated the need to examine the relevant experiences, attitudes and characteristics of teachers for whom the curriculum was intended. For this reason, data were collected and analyzed as an important step in designing the curriculum.

The procedures used to conduct the study are presented in Chapter 3. This chapter is divided into three sections: 1) population and sample, 2) data collection procedures, and 3) statistical procedures for data analysis.

Population and Sample

The population of this study was all elementary school teachers in Stockton Unified School District. This included teachers of kindergarten through sixth grade. The population surveyed consisted of all teachers in nine elementary schools.

The nine elementary schools were selected on the basis of interest in teacher computer literacy as expressed by the school principal. This selection process had two steps, and was accomplished in cooperation with Stockton
Unified School District central office administration. In the first step, all elementary school principals were approached by the director of the Research and Evaluation Department of Stockton Unified School District. Referrals of those principals who expressed interest were made to the researcher and appointments were made to discuss participation in the study. At this interview, a general overview of the study was given. All principals who were contacted agreed to participate and facilitate administration of the teacher survey.

**Data Collection Procedures**

Survey administration. The teacher survey was administered in May 1982. School principals provided time during regularly scheduled faculty meetings for teachers to complete the survey. This required approximately ten minutes. Participation by the teachers was voluntary and responses were confidential. In most cases teachers completed the surveys at that time, although some surveys were completed and returned after the faculty meeting. Of 196 teachers who received surveys, 149 completed and returned them. This was a return rate of 76%.

Teachers in the elementary schools were of two types. The majority were classroom teachers, but a few were specialists. The specialists served as resource teachers for the classroom teachers and generally did not have a
regular class assignment. For the purpose of this study, specialists were surveyed along with classroom teachers, since both categories of teachers would attend computer literacy inservice.

Instrumentation. Data were collected with a survey which was developed by the researcher. It was designed to gather the information below. Following each item is the name of the variable, except in the case of the first item, confirmation of teacher status. This item did not enter into the statistical treatment, but was used to eliminate any surveys completed by principals, teachers' aides, and other non teachers.

1. Confirmation of teacher status.
2. Sex. (SEX)
3. Years of teaching experience. (YEARS)
4. Number of college mathematics courses completed. (MATH)
5. Previous computer related training. (TRAINING)
6. Previous computer experience. (EXPERIENCE)
7. Attitude toward teacher responsibility for providing computer literacy instruction for students. (RESPONSIBILITY)
8. Attitude toward the efficacy of computers as teaching tools. (EFFICACY)
9. Attitude toward computers in general. (ATTITUDE)
10. Commitment to learning about computer use in education. (COMMITMENT)
11. Computer literacy topics that are perceived important for teachers. (TOPIC 1 - TOPIC 30)

Because it was anticipated that some teachers would have very little knowledge of computers and computer terminology, an attempt was made to avoid unnecessary use of specialized computer vocabulary in the survey. However, in presenting the computer literacy topics it was impossible to avoid using at least some computer terminology. As a result, short explanations of these terms were included in the survey just above the computer literacy items.

Statistical Procedures for Data Analysis

The purpose of collecting data was twofold. First, the data yielded a general description of the population for which the curriculum was designed. Second, the data allowed investigation of factors that helped determine content and activities in the curriculum.

The survey results were coded and entered into a data file on the computer at the University of the Pacific. Statistical analysis was completed using the Statistical Package for the Social Sciences.

A number of descriptive analyses were made. These are shown in Figure 3. In addition, five research hypotheses were investigated. Alpha levels for the multiple regression and correlation analyses were set at .10. The research hypotheses appear in Figure 4.
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<thead>
<tr>
<th>Item</th>
<th>VARIABLE</th>
<th>STATISTICAL TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>SEX</td>
<td>frequency</td>
</tr>
<tr>
<td>Number of years of teaching experience</td>
<td>YEARS</td>
<td>frequency, mean</td>
</tr>
<tr>
<td>Number of college math courses completed</td>
<td>MATH</td>
<td>frequency, mean</td>
</tr>
<tr>
<td>Previous training in computer use</td>
<td>TRAINING</td>
<td>frequency</td>
</tr>
<tr>
<td>Previous experience with computers</td>
<td>EXPERIENCE</td>
<td>frequency</td>
</tr>
<tr>
<td>Attitude toward responsibility of teachers to provide computer literacy for students</td>
<td>RESPONSIBILITY</td>
<td>frequency, median</td>
</tr>
<tr>
<td>Attitude toward efficacy of computers as teaching tool</td>
<td>EFFICACY</td>
<td>frequency, median</td>
</tr>
<tr>
<td>Commitment to learning about computers</td>
<td>COMMITMENT</td>
<td>frequency</td>
</tr>
<tr>
<td>Computer literacy topics</td>
<td>TOPIC 1 to TOPIC 30</td>
<td>mean</td>
</tr>
</tbody>
</table>
Figure 4

RESEARCH HYPOTHESES

<table>
<thead>
<tr>
<th>HYPOTHESIS</th>
<th>VARIABLE</th>
<th>STATISTICAL TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is a correlation between number of college math courses and attitude toward computers</td>
<td>MATH, ATTITUDE</td>
<td>Spearman's rho</td>
</tr>
<tr>
<td>There is a correlation between years of teaching and attitude toward computers</td>
<td>YEARS, ATTITUDE</td>
<td>Spearman's rho</td>
</tr>
<tr>
<td>There is a correlation between attitude toward computers and computer literacy topics perceived to be important</td>
<td>ATTITUDE, TOPIC 1 to TOPIC 30</td>
<td>multiple regression</td>
</tr>
<tr>
<td>There is a correlation between commitment to learning about computers and computer literacy topics perceived to be important</td>
<td>COMMITMENT, TOPIC 1 to TOPIC 30</td>
<td>multiple regression</td>
</tr>
</tbody>
</table>
Chapter 4

PRESENTATION AND ANALYSES OF THE DATA

The data and their analyses are presented in this chapter. This presentation is divided into two parts. The first part includes the descriptive analyses. The second part consists of the research hypotheses. In the latter part, each null hypothesis is stated, variables used are discussed, the results of the statistical analyses are presented, and the decision to accept or reject the null hypothesis is made.

Analysis of the data was accomplished through the Statistical Package for the Social Sciences which was available at the University of the Pacific. The computer utilized was a Burroughs 6700.

Descriptive Analyses

The majority of the respondents were female. Table 1 shows the frequency and percentage of female and male respondents.

The respondents displayed a wide range of years of teaching experience. The least experience was one year; the most experience reported was forty years. The average number of years of teaching was 14.5. The range and frequencies are shown in Table 2.
Table 1

SEX OF RESPONDENTS

<table>
<thead>
<tr>
<th>Sex</th>
<th>Absolute Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>21</td>
<td>14.1</td>
</tr>
<tr>
<td>female</td>
<td>125</td>
<td>83.9</td>
</tr>
<tr>
<td>no answer</td>
<td>3</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>149</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 2

YEARS OF TEACHING EXPERIENCE

<table>
<thead>
<tr>
<th>Years</th>
<th>Absolute Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>21</td>
<td>14.1</td>
<td>14.1</td>
</tr>
<tr>
<td>6-10</td>
<td>32</td>
<td>21.5</td>
<td>35.6</td>
</tr>
<tr>
<td>11-15</td>
<td>37</td>
<td>24.8</td>
<td>60.4</td>
</tr>
<tr>
<td>16-20</td>
<td>22</td>
<td>14.8</td>
<td>75.2</td>
</tr>
<tr>
<td>21-25</td>
<td>14</td>
<td>9.4</td>
<td>84.6</td>
</tr>
<tr>
<td>26-30</td>
<td>15</td>
<td>10.0</td>
<td>94.6</td>
</tr>
<tr>
<td>31-40</td>
<td>3</td>
<td>2.0</td>
<td>96.6</td>
</tr>
<tr>
<td>no answer</td>
<td>5</td>
<td>3.4</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>149</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

mean = 14.5 years
The majority of respondents reported having taken three or fewer college mathematics courses. The number of mathematics courses reported taken ranged from zero to more than five. The mean number of courses reported was slightly more than three. Table 3 contains a summary of this information.

Table 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Absolute Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>11</td>
<td>7.4</td>
<td>7.4</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
<td>13.4</td>
<td>20.8</td>
</tr>
<tr>
<td>2</td>
<td>32</td>
<td>21.5</td>
<td>42.3</td>
</tr>
<tr>
<td>3</td>
<td>34</td>
<td>22.8</td>
<td>65.1</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>8.7</td>
<td>73.8</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>2.7</td>
<td>76.5</td>
</tr>
<tr>
<td>more than 5</td>
<td>13</td>
<td>8.7</td>
<td>85.2</td>
</tr>
<tr>
<td>no answer</td>
<td>22</td>
<td>14.8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

mean = 3.10 (n=127)

Few teachers reported they had received training in the use of computers. A large majority indicated they had not attended any workshops or courses related to educational uses of computers. Table 4 summarizes this.

Most teachers reported they had never used a computer. Those who indicated they had used a computer reported whether they had used it in their own classroom or if they had only used it outside the classroom. Of those who had used one, very few indicated using it in the classroom. See Table 5 for a summary.
Table 4
ATTENDED PREVIOUS WORKSHOPS OR COURSES ON COMPUTER USE IN EDUCATION

<table>
<thead>
<tr>
<th>Response</th>
<th>Absolute Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>124</td>
<td>83.2</td>
</tr>
<tr>
<td>yes</td>
<td>24</td>
<td>16.1</td>
</tr>
<tr>
<td>no answer</td>
<td>1</td>
<td>.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>149</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Table 5
PREVIOUS COMPUTER USE

<table>
<thead>
<tr>
<th>Response</th>
<th>Absolute Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>92</td>
<td>61.7</td>
</tr>
<tr>
<td>yes in class</td>
<td>11</td>
<td>7.4</td>
</tr>
<tr>
<td>not in class</td>
<td>45</td>
<td>30.2</td>
</tr>
<tr>
<td>no answer</td>
<td>1</td>
<td>.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>149</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
In general, respondents agreed that teachers have a responsibility to prepare students to live in a computer oriented society. The median responses of this item fell between "agree" and "strongly agree" on a four point scale from "strongly agree" to "strongly disagree." Table 6 summarizes the responses to this item.

Table 6
RESPONSE TO STATEMENT: TEACHERS ARE RESPONSIBLE FOR PREPARING STUDENTS FOR COMPUTER ORIENTED SOCIETY

<table>
<thead>
<tr>
<th>Response</th>
<th>Absolute Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree (4)</td>
<td>50</td>
<td>33.6</td>
<td>33.6</td>
</tr>
<tr>
<td>Agree (3)</td>
<td>85</td>
<td>57.0</td>
<td>90.6</td>
</tr>
<tr>
<td>Disagree (2)</td>
<td>5</td>
<td>3.4</td>
<td>94.0</td>
</tr>
<tr>
<td>Strongly disagree (1)</td>
<td>1</td>
<td>.7</td>
<td>94.7</td>
</tr>
<tr>
<td>no answer</td>
<td>8</td>
<td>5.4</td>
<td>100.0</td>
</tr>
</tbody>
</table>

median = 3.11 (n=141)

*Sum not equal to 100% due to rounding error.

Most teachers agree that computers are becoming increasingly effective at teaching students. The median level of agreement on this item fell slightly below "agree" but well above "disagree." Table 7 summarizes the responses to this item.

Commitment to learning about computers was measured with three variables, each related to a separate element. These elements were cost (free/at personal expense), scheduling (released during school hours/on own time) and time
Table 7
RESPONSE TO STATEMENT: COMPUTERS ARE BECOMING INCREASINGLY EFFECTIVE AT TEACHING STUDENTS

<table>
<thead>
<tr>
<th>Response</th>
<th>Absolute Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree (4)</td>
<td>20</td>
<td>13.4</td>
<td>13.4</td>
</tr>
<tr>
<td>Agree (3)</td>
<td>86</td>
<td>57.7</td>
<td>71.1</td>
</tr>
<tr>
<td>Disagree (2)</td>
<td>25</td>
<td>16.8</td>
<td>87.9</td>
</tr>
<tr>
<td>Strongly disagree (1)</td>
<td>1</td>
<td>0.7</td>
<td>88.6</td>
</tr>
<tr>
<td>no answer</td>
<td>17</td>
<td>11.4</td>
<td>100.0</td>
</tr>
</tbody>
</table>

\[ \text{median} = 2.93 \ (n=132) \]
(a one day session/ a week long session/ a semester long college course). The respondents indicated under which conditions they would attend a training session on computers. The time element was analyzed to determine if the items formed a Guttman scale. They did not, so the element was categorized according to how many of the conditions the respondent indicated were acceptable. Information on the frequency of each of the time elements is included in Table 8 with the rest of the commitment information.

The final descriptive analysis was related to the computer literacy topics. Teachers indicated how important they thought learning each individual topic was. They selected from these responses: very important, important, somewhat important, not important. The analysis was made by examining the means of all computer literacy topics to determine whether it was possible to rank them by the relative degree of importance as perceived by the teachers. Most respondents answered all the computer literacy topic items. However, each topic had a few respondents who did not answer. These were recoded to a value of 2.5, the median value on the scale. The scores on the computer literacy topics reflect the respondents' perception of the importance of each. Teachers tended to view as more important those items that involved actually using the computer; items related to learning about the impact of computers were ranked as less important. However, all topics were ranked in the "important" to "very important" range. See Table 9.
Table 8

COMMITMENT TO LEARNING ABOUT COMPUTERS:
CONDITIONS UNDER WHICH RESPONDENT
WOULD ATTEND TRAINING

COST ELEMENT

<table>
<thead>
<tr>
<th>Response</th>
<th>Absolute Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under no conditions</td>
<td>25</td>
<td>16.8</td>
<td>16.8</td>
</tr>
<tr>
<td>Only if training is free</td>
<td>109</td>
<td>73.2</td>
<td>89.9</td>
</tr>
<tr>
<td>Both if training is free and at own expense</td>
<td>15</td>
<td>10.1</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>149</strong></td>
<td><strong>100.1</strong></td>
<td></td>
</tr>
</tbody>
</table>

SCHEDULING ELEMENT

<table>
<thead>
<tr>
<th>Response</th>
<th>Absolute Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under no conditions</td>
<td>22</td>
<td>14.8</td>
<td>14.8</td>
</tr>
<tr>
<td>Only if during school time</td>
<td>85</td>
<td>57.0</td>
<td>71.8</td>
</tr>
<tr>
<td>Both if during school time and on personal time</td>
<td>42</td>
<td>28.2</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>149</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

TIME ELEMENT

<table>
<thead>
<tr>
<th>Response</th>
<th>Absolute Frequency</th>
<th>Percent</th>
<th>Cumulative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under no conditions</td>
<td>38</td>
<td>25.5</td>
<td>25.5</td>
</tr>
<tr>
<td>Under one condition</td>
<td>62</td>
<td>41.6</td>
<td>67.1</td>
</tr>
<tr>
<td>Under two conditions</td>
<td>32</td>
<td>21.5</td>
<td>88.6</td>
</tr>
<tr>
<td>Under all conditions</td>
<td>17</td>
<td>11.4</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>149</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Sum not equal to 100% due to rounding error.
<table>
<thead>
<tr>
<th>Ranking</th>
<th>Topic</th>
<th>Topic #</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Learn to operate a simple computer.</td>
<td>9</td>
<td>3.359</td>
</tr>
<tr>
<td>2</td>
<td>Understand the steps of a simple program.</td>
<td>11</td>
<td>3.262</td>
</tr>
<tr>
<td>3</td>
<td>Explain what a simple program does.</td>
<td>12</td>
<td>3.141</td>
</tr>
<tr>
<td>4</td>
<td>Make modifications in a simple program.</td>
<td>13</td>
<td>3.101</td>
</tr>
<tr>
<td>5</td>
<td>Find errors in a simple program.</td>
<td>14</td>
<td>3.070</td>
</tr>
<tr>
<td>6</td>
<td>Know how to organize information so a computer could use it.</td>
<td>18</td>
<td>3.040</td>
</tr>
<tr>
<td>7</td>
<td>Know the major uses of computers in education.</td>
<td>23</td>
<td>3.017</td>
</tr>
<tr>
<td>8</td>
<td>Write a simple program to solve one problem.</td>
<td>15</td>
<td>2.950</td>
</tr>
<tr>
<td>9</td>
<td>Write a simple program to solve several similar problems.</td>
<td>16</td>
<td>2.943</td>
</tr>
<tr>
<td>10</td>
<td>Use computer programs prepared by others.</td>
<td>20</td>
<td>2.933</td>
</tr>
<tr>
<td>11</td>
<td>Determine the usefulness of a given computer program.</td>
<td>21</td>
<td>2.886</td>
</tr>
<tr>
<td>12</td>
<td>Learn the history of computers.</td>
<td>7</td>
<td>2.879</td>
</tr>
<tr>
<td>13</td>
<td>Be able to explain what a computer algorithm is.</td>
<td>10</td>
<td>2.802</td>
</tr>
<tr>
<td>14</td>
<td>Learn about different programming languages used in education.</td>
<td>24</td>
<td>2.785</td>
</tr>
<tr>
<td>15</td>
<td>Evaluate the quality of a given computer program.</td>
<td>22</td>
<td>2.772</td>
</tr>
<tr>
<td>16</td>
<td>Consider whether computers make individuals more or less dependent on their own abilities.</td>
<td>30</td>
<td>2.752</td>
</tr>
<tr>
<td>17</td>
<td>Examine new applications of computers in education.</td>
<td>26</td>
<td>2.745</td>
</tr>
<tr>
<td>18</td>
<td>Understand the difference between computer hardware and software.</td>
<td>6</td>
<td>2.738</td>
</tr>
<tr>
<td>19</td>
<td>Understand how a computer processes information.</td>
<td>5</td>
<td>2.732</td>
</tr>
<tr>
<td>19</td>
<td>Learn about factors that limit educational uses of computers.</td>
<td>25</td>
<td>2.732</td>
</tr>
<tr>
<td>20</td>
<td>Identify several ways that computers receive information.</td>
<td>4</td>
<td>2.718</td>
</tr>
<tr>
<td>21</td>
<td>Learn criteria for selecting hardware.</td>
<td>3</td>
<td>2.634</td>
</tr>
<tr>
<td>22</td>
<td>Examine how computers may personalize or depersonalize education.</td>
<td>29</td>
<td>2.611</td>
</tr>
<tr>
<td>23</td>
<td>Know the major parts and functions of the hardware in a computer system.</td>
<td>2</td>
<td>2.604</td>
</tr>
<tr>
<td>24</td>
<td>Develop new applications of computers in education.</td>
<td>27</td>
<td>2.564</td>
</tr>
<tr>
<td>25</td>
<td>Know how computers store information.</td>
<td>17</td>
<td>2.537</td>
</tr>
<tr>
<td>26</td>
<td>Understand why computers need programs.</td>
<td>19</td>
<td>2.490</td>
</tr>
<tr>
<td>27</td>
<td>Learn how the human brain and a computer are alike and different.</td>
<td>8</td>
<td>2.403</td>
</tr>
<tr>
<td>28</td>
<td>Examine the effects of computers on society outside the educational setting.</td>
<td>28</td>
<td>2.396</td>
</tr>
<tr>
<td>29</td>
<td>Learn what happens inside a computer when it operates.</td>
<td>1</td>
<td>2.332</td>
</tr>
</tbody>
</table>
Analyses of Research Hypotheses

The first and second null hypotheses were related to correlations between attitude toward computers and number of college math classes taken and years of teaching experience. The hypotheses were:

1. There is no correlation between number of college math courses reported and attitude toward computers.

2. There is no correlation between years of teaching and attitude toward computers.

Attitude was measured by eight separate items which were summed to give a total attitude score. Alpha reliability for the attitude items was 0.75737 (See appendix D for the reliability table). The Spearman correlation was used to test null hypotheses 1 and 2. Both null hypotheses were rejected since the correlations were significant at an alpha level of 0.10. For this group a more positive attitude toward computers was related to having taken more college math courses. Also, the fewer the years of teaching, the more positive an attitude toward computers an individual was likely to have. To restate this latter relationship, the more years an individual had taught, the less likely he was to have a more positive attitude toward computers. Table 10 presents the results.

The third and fourth null hypotheses were related to the relationship between attitude and commitment and perception of importance of the computer literacy topics. These hypotheses were:
Table 10

CORRELATIONS OF ATTITUDE WITH NUMBER OF COLLEGE MATH COURSES AND YEARS OF TEACHING

<table>
<thead>
<tr>
<th>Variable</th>
<th>Spearman's rho</th>
<th>Significance</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math classes</td>
<td>0.1427</td>
<td>.055</td>
<td>127</td>
</tr>
<tr>
<td>Years of teaching</td>
<td>-0.1881</td>
<td>.012</td>
<td>144</td>
</tr>
</tbody>
</table>
3. There is no relationship between attitude toward computers and the perceived importance of the computer literacy topics.

4. There is no relationship between commitment to learning about computers and the perceived importance of the computer literacy topics.

These hypotheses were tested with multiple regression analysis. Before performing the multiple regression, factor analysis was applied to the computer literacy topics to identify any unsuspected underlying pattern of relationships between the topics. The factor analysis failed to reveal any pattern inconsistent with the groupings of topics suggested in the literature. The computer literacy topics were divided into three factors, as follows:

1. **Factor One: Components and function of computer systems.**
   
   **Topic 1.** Learn what happens inside a computer when it operates.
   
   **Topic 2.** Know the major parts and functions of the hardware in a computer system.
   
   **Topic 3.** Learn criteria for selecting hardware.
   
   **Topic 4.** Identify several ways that computers receive information.
   
   **Topic 5.** Understand how a computer processes information.
   
   **Topic 6.** Understand the difference between computer hardware and software.
   
   **Topic 7.** Learn the history of computers.
   
   **Topic 8.** Learn how the human brain and a computer are alike and are different.

2. **Factor Two: Operating and programming a computer.**
3. Factor Three: Applications of computers.

Topic 9. Learn to operate a simple computer.

Topic 10. Be able to explain what a computer algorithm is.

Topic 11. Understand the steps of a simple program.

Topic 12. Explain what a simple program does.


Topic 14. Find errors in a simple program.

Topic 15. Write a simple program to solve one problem.

Topic 16. Write a simple program to solve several similar problems.

Topic 17. Know how computers store information.

Topic 18. Know how to organize information so a computer could use it.

Topic 19. Understand why computers need programs.

Topic 20. Use computer programs prepared by others.

Topic 21. Determine the usefulness of a given computer program.

Topic 22. Evaluate the quality of a given computer program.

Topic 23. Know the major uses of computers in education.

Topic 24. Learn about different programming languages used in education.

Topic 25. Learn about factors that limit educational uses of computers.

Topic 27. Develop new applications of computers in education.

Topic 28. Examine the effects of computers on society outside the educational setting.

Topic 29. Examine how computers may personalize or depersonalize education.

Topic 30. Consider whether computers make individuals more or less dependent on their own abilities.

Alpha reliability of each factor was calculated and found to be the following:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor One</td>
<td>0.84416</td>
</tr>
<tr>
<td>Factor Two</td>
<td>0.93577</td>
</tr>
<tr>
<td>Factor Three</td>
<td>0.90849</td>
</tr>
</tbody>
</table>

An initial multiple regression analysis was made for both dependent variables, attitude and commitment, using all the individual computer literacy topics as independent variables. This was intended to find the computer literacy topic that was the single best predictor of attitude and of commitment. For attitude, the single best predictor was Topic 9 (learning to operate a simple computer). That is, the more positive the attitude, the more likely the individual was to believe learning to operate a simple computer was important. For commitment the single best predictor was Topic 16 (learning to write a simple program to solve several similar problems). For the multiple regression summary tables for commitment and attitude with the individual computer literacy topics, see Appendix E.

The null hypotheses were tested using a two step multiple regression, with the three computer literacy
factors and attitude or commitment entered on the first step. Then these variables were entered on the second step: sex, years, of teaching, number of mathematics courses, previous computer training, and previous use of computers. Table 11 summarizes the multiple regression for null hypothesis three. The null hypothesis was rejected. It is clear that the best predictor of attitude was Factor Two, followed by commitment and previous training. Of the computer literacy topics, the ones that focused on using a computer and writing programs were most closely correlated to positive attitude toward computers. Table 12 summarizes the multiple regression analysis for null hypothesis four. Again, the null hypothesis was rejected. As with attitude, the best predictor of commitment was Factor Two. Factor Three was the next best predictor, followed by attitude and Factor One.

Summary

In this chapter, the descriptive analyses and the analyses of the null hypotheses were presented. All the null hypotheses were rejected. A summary and interpretation of the results follow in Chapter 5.
### Table 11
MULTIPLE REGRESSION: VARIABLES PREDICTING ATTITUDE TOWARD COMPUTERS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Simple R</th>
<th>Beta</th>
<th>F (df=9,139)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor One</td>
<td>0.21198**</td>
<td>0.04755</td>
<td>0.339</td>
</tr>
<tr>
<td>Factor Two</td>
<td>0.50379**</td>
<td>0.31426</td>
<td>11.642**</td>
</tr>
<tr>
<td>Factor Three</td>
<td>0.37117**</td>
<td>-0.00994</td>
<td>0.010</td>
</tr>
<tr>
<td>Commitment</td>
<td>0.48454**</td>
<td>0.21926</td>
<td>6.750**</td>
</tr>
<tr>
<td>Sex</td>
<td>0.09525</td>
<td>0.05334</td>
<td>0.569</td>
</tr>
<tr>
<td>Years of teaching</td>
<td>-0.21060**</td>
<td>-0.14293</td>
<td>4.203**</td>
</tr>
<tr>
<td>Math courses</td>
<td>0.19345*</td>
<td>0.13816</td>
<td>3.657**</td>
</tr>
<tr>
<td>Previous training</td>
<td>0.28979**</td>
<td>0.04882</td>
<td>0.373</td>
</tr>
<tr>
<td>Previous use</td>
<td>0.27985**</td>
<td>0.15932</td>
<td>4.441**</td>
</tr>
</tbody>
</table>

Total Multiple R Square = 0.39160

** Significant at .01
* Significant at .10

### Table 12
MULTIPLE REGRESSION: VARIABLES PREDICTING COMMITMENT TO LEARNING ABOUT COMPUTERS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Simple R</th>
<th>Beta</th>
<th>F (df=9,139)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor One</td>
<td>0.09674</td>
<td>-0.10650</td>
<td>6.257**</td>
</tr>
<tr>
<td>Factor Two</td>
<td>0.51981**</td>
<td>0.30107</td>
<td>11.048**</td>
</tr>
<tr>
<td>Factor Three</td>
<td>0.41532**</td>
<td>0.21725</td>
<td>4.922**</td>
</tr>
<tr>
<td>Attitude</td>
<td>0.48454**</td>
<td>0.21124</td>
<td>6.750**</td>
</tr>
<tr>
<td>Sex</td>
<td>0.12899*</td>
<td>0.06472</td>
<td>0.872</td>
</tr>
<tr>
<td>Years of teaching</td>
<td>-0.23514**</td>
<td>-0.14177</td>
<td>4.295**</td>
</tr>
<tr>
<td>Math courses</td>
<td>0.09206</td>
<td>0.00535</td>
<td>0.006</td>
</tr>
<tr>
<td>Previous training</td>
<td>0.20017**</td>
<td>0.08963</td>
<td>1.312</td>
</tr>
<tr>
<td>Previous use</td>
<td>0.21115**</td>
<td>0.07008</td>
<td>0.870</td>
</tr>
</tbody>
</table>

Total Multiple R Square = 0.41386

** Significant at .01
* Significant at .10
Chapter 5

SUMMARY, DISCUSSION, CONCLUSIONS
AND RECOMMENDATIONS

This chapter consists of four sections. In the first, the study and statistical analyses are summarized. The second section includes discussion of the findings and presents interpretation and explanation of the findings as related to the review of the literature. The third section includes a summary of the curriculum development method employed and an outline of the teacher computer literacy curriculum. The final section is composed of recommendations for use of the results of this study as well as for future research.

Summary

The main purpose of this study was to develop a computer literacy curriculum for elementary school teachers. The philosophical approach to the development of the curriculum was based on selected works of John Dewey. Data were collected from elementary school teachers as a means of gaining enough familiarity with the teachers, their interests and experiences to develop a curriculum that would be acceptable and appropriate.

This study was not designed to be generalized to a large population. As was pointed out in Chapter 2, the
philosophical basis of this curriculum was developed out of the writings of John Dewey. One of the main points Dewey made was the importance of curriculum relating closely to those for whom it was intended. This curriculum, then, was intended for a specific group of elementary school teachers. However, because of the manner in which teachers were included in the study, there was no reason to believe these teachers were not typical elementary teachers. They were included in the study because the principals in their schools expressed interest in the idea of teacher computer literacy. Therefore, with the understanding that the major purpose of the study was not to explain aspects of a larger population, some tentative generalizations could be drawn.

The elementary school teachers surveyed were mainly women. A small number of men, less than 15 percent, were included. This was interpreted as a reflection of the preponderance of female elementary school teachers rather than any particular bias in the group surveyed. Most of the respondents could be accurately described as experienced teachers, since less than 15 percent of the total had taught for five or fewer years. Thus, a group of veteran female teachers was the target of the computer literacy curriculum.

Regarding the number of college mathematics courses taken, nearly three-quarters of the respondents reported having taken four or fewer. The average number of mathematics courses reported was about three. It was interesting that almost 15 percent of the respondents did not
answer this question. More respondents left this item unanswered than any other item. Because the respondents were generally cooperative in answering, it would not seem unreasonable to interpret these non-answers as either indicating no math courses taken or no clear memory of college math courses taken. Thus, a lack of response to this item could have reflected the respondent's perception of having little or no mathematics background. Under the circumstances, these cases could have been recoded as having had no mathematics classes. If this were done, the mean number of mathematics classes would have dropped to slightly below three (mean = 2.87) and then nearly 80 percent of the respondents would have reported three or fewer college mathematics courses taken. Since the Multiple Subject Credential, under which most elementary school teachers teach, required a minimum of two mathematics courses, the teachers appeared to average about one course more than the bare minimum. Few could be described as having a strong background in mathematics.

Most of the teachers had little experience with computer use in education. More than 80 percent reported never attending any workshops or courses on the educational uses of computers. The majority of teachers said they had never used a computer, and only 7.5 percent had used a computer in their own classroom. However, nearly one third of the teachers reported having used a computer in some situation outside their classroom. Thus, while the teachers
did not have much exposure to computers in educational situations, nearly 40 percent had used a computer in some context. The group could accurately be characterized as mostly inexperienced, particularly with regard to educational uses of computers. However, a large part of the teachers had contact with a computer at some time.

In spite of this relative inexperience, the teachers overwhelmingly agreed (90.6%) that as teachers they had a responsibility to prepare students to live in a computer oriented society. However, teachers were less certain that computers actually were becoming increasingly effective at teaching students, although the majority (71.1%) did agree with that statement. These findings may indicate some ambivalence on the part of teachers: while they agreed schools should prepare students to deal with computers in their lives, teachers themselves might not be quite as anxious to deal with computers in their own professional lives. This might also reflect the belief that while computers were becoming widespread and very useful in many ways, education was an an area in which their usefulness was more limited. It was important to note that, in general, teachers expressed agreement with the concepts of teacher responsibility for student computer literacy and of the usefulness of computers in education.

Teachers' commitment to learning about computers was measured in terms of three elements, cost, scheduling and time. The majority of teachers indicated they would attend
training only if it were free, and only if they were released during school time to attend. The time element did give as straightforward a pattern, although about 40 percent of the teachers indicated they would attend training only under one of the time conditions. Of these time conditions, 55 percent of the teachers stated they would attend a one day session, 41 percent a one week session, and 23 percent a semester long course. In general, the data indicated that the teachers would be more likely to attend training if it was incorporated into their regular schedule and if they did not have to pay for it themselves. It appeared that teachers were unlikely to seek out training on their own initiative. This finding, taken together with teachers' agreement that they were responsible for preparing students for a computer oriented society, illustrated an interesting situation. In essence, teachers seemed to be waiting for the necessary training to come to them, rather than actively seeking it. Perhaps teachers did not feel personally responsible for staying abreast of new technology, or perhaps they felt the field of computers was too complex for them to be able to determine in what method to begin learning.

The computer literacy topics that were perceived to be of most importance were those related to operating a computer and preparing programs. This could be interpreted to suggest that teachers' main concern was gaining some familiarity with and control over computers. Since the majority
of teachers were not very experienced with computers, they might be particularly interested in direct, immediate use of the computer. In general, it seemed that teachers' first concern was that they be able to operate a computer and control in some way its workings. This then would seem a logical focus for beginning the computer literacy curriculum. After gaining some initial skills, teachers might rank the remaining computer literacy topics differently. Since the perception of importance of topics was based on widespread ignorance of computers, any ranking of topics must be viewed as tentative and flexible. However, since teachers saw as more important those topics related to using and programming computers, it was appropriate to begin with these and allow ample opportunity to change the focus of the curriculum as the teachers became more knowledgeable.

Attitude toward computers was related to two specific factors, number of college math courses taken and years of teaching experience. Both correlations were low but significant. Number of mathematics courses was correlated positively with attitude. That is, the more mathematics classes taken, the more positive was the attitude toward computers. Since success in using computers was often perceived to be related to mathematical competence, teachers with more background in mathematics might believe themselves better prepared to learn about computers than those who took fewer mathematics classes. In contrast, the correlation between attitude toward computers and number of
years of teaching was negative. Thus, the more years of teaching experience, the less positive was the attitude toward computers. More experienced teachers might be more likely to have adopted a preferred style of teaching, developed over the years, which they were reluctant to modify with a new technology. Less experienced teachers might foresee for themselves many years of teaching in which computers would be available, and so viewed it as necessary to learn to use them. Whatever the cause, teachers with fewer years of teaching experience were likely to have somewhat more positive attitudes toward computers.

Multiple regression revealed that the single variable most highly correlated with attitude was Factor Two, which included the computer literacy topics related to operating and programming a computer. The other two sets of factors were not significant predictors of attitude. These were, in order of explanatory value, commitment, previous computer use, number of years of teaching, and number of college mathematics courses. The correlation was positive for all the variables except number of years of teaching. The finding suggested that people with most positive attitude toward computers were those who believed it was most important to learn to use and program a computer, those who were most committed to learning about computers, those who had some previous computer use, those who had taken more college mathematics courses, and those who had taught fewer years.
As with attitude, the multiple regression revealed that the single variable that was the best predictor of commitment to learning about computers was Factor Two. Those teachers most committed to learning believed it was important to learn to use and program a computer. The other variables that were significant predictors of commitment were attitude, Factor Three, Factor One and number of years of teaching. Teachers who were committed to learning were more likely to identify as important all three groups of computer literacy topics, to have a positive attitude toward computers, and to have taught fewer years.

Discussion

The following section of this chapter reviews some of the material presented in Chapter 2, Review of the Literature. Topics from Chapter 2 are examined in light of the data analysis.

It was suggested that computer literacy could be viewed as a hierarchy of skills. In general, writing computer programs was not identified as a beginning level skill. Some authors suggested an awareness of the impact of computers or an understanding of computer systems was an appropriate starting point for the novice. However, the teachers in this study identified operating a computer and writing programs as the most important in the range of computer literacy topics. Therefore, methods of structuring computer literacy instruction which were suggested in the
literature were not appropriate for this group of teachers. These teachers indicated that they felt it was important to begin using and controlling the computer immediately.

It was interesting to note that the topics teachers believed most important for them to learn were not directly related to students. In the literature it was suggested that teachers should become computer literate so they could help students cope with a world permeated with computers. However, teachers tended to rank higher those topics that related to teacher control over the computer rather than topics that explored the impact of computers on their students' lives. This certainly did not indicate that teachers considered the latter to be unimportant, but rather that such topics were not viewed as important as those that focused on the teacher controlling the computer. In essence, the viewpoint often presented in the literature was of teacher computer literacy serving as a vehicle for student computer literacy. In contrast, the teachers in this study tended to see teacher computer literacy, at least at this stage in their computer knowledge, as an end in itself.

Two categories of factors were cited in Chapter 2 as impeding teacher computer literacy. These factors were attitudes toward computers and lack of opportunity for training. It was suggested that many teachers had negative attitudes toward computers or questioned the relevance of computers in the curriculum. Based on the responses in this study, neither of these appeared true for this group of
teachers. In fact, the majority of teachers demonstrated positive attitudes toward computers and agreed that teachers were responsible for preparing students to live in a computer oriented society. In spite of this apparent positive attitude, however, few teachers had received any training in computer use in education. While this might indeed be related to a general lack of learning opportunities, it might also be related to the degree of commitment on the part of the teachers to obtain training. The majority of teachers indicated they would only attend training that was free of cost and for which they were released from their regular teaching duties to attend. This suggested teachers might continue to have little knowledge of computers because this particular learning opportunity was not available. They appeared willing to learn about computers if they did not have to invest their own time and money. Thus, the major reasons cited for lack of computer knowledge in the literature were not clearly evident in this study.

However, it was also suggested that knowledge of computers was identified as related to knowledge of mathematics. Thus, those with little training in mathematics might be expected to feel less enthusiastic about computers. For this study, this appeared to be true. Although the correlation between attitude and number of college mathematics courses taken was low, it was significant. This suggested the wisdom of taking a non mathematical approach to teaching about programming. This could be done by
devising verbal rather than mathematical examples of programming commands and providing sample programs in a wide variety of content areas. For this group of teachers, a computer literacy curriculum should take the form of an inservice held during regular work hours, beginning immediately with learning to use a computer and to write programs while avoiding a strong mathematical approach.

In examining the theory of innovation adoption, it was noted that the factors impeding innovation could be summarized as reflecting one of these negative conditions:

1. No problem has been identified or acknowledged. The innovation is rejected because it is not perceived as needed.

2. A problem has been acknowledged, and solutions sought. However, the innovation is not perceived to be the best solution.

3. There is little or no knowledge of the innovation, so uses of it are not sought.

4. Some individuals have knowledge of the innovation, perceive uses of it, but have not convinced others to adopt the innovation.

5. The expectations of society of what the educational system should produce have not changed to require the innovation. There is no need for the innovation, so educational resources have not been allocated to implement it.

It was not the purpose of this study to directly investigate these conditions. However, some information arising from the data was informative. The study suggested that teachers had little knowledge of computers. Therefore, it was not likely that teachers would serve to inform others of the uses of computers in education and convince them to use
computers. Nor would teachers be likely to know particular applications of computers in education and seek to have those adopted. Thus the view that innovations might be adopted in schools as a result of new ideas brought in by personnel did not appear to hold for this group of teachers. The majority did not know much about computers, so the third condition which was identified as impeding adoption of innovation did exist in this case.

Finally, the philosophy of John Dewey and how it served as a guide to the computer literacy curriculum was addressed in the review of the literature. One of the implications of Dewey's philosophy was that teachers must be involved in selecting aims of the curriculum. As mentioned above, the teachers identified learning to use a computer and write programs as the primary aim of the curriculum. This aim coincided with Dewey's belief that learning takes place through activity and experience. The teachers identified as most important an aim that demanded immediate mental and physical interaction with a computer. Thus the basis of the curriculum was in concrete experiences as Dewey believed was essential. It was interesting that the teachers themselves identified this as most important.

Conclusions

Although the main focus of this study was to design a computer literacy curriculum, a related purpose was to illustrate the curriculum design method used. This
curriculum design method resulted in a computer literacy curriculum based on Dewey's philosophy and prepared for a specific identified group of students. In this section the method used in approaching the curriculum design is summarized. Then a brief overview of the computer literacy curriculum is presented. The entire curriculum is contained in Appendix F.

Method of curriculum design. The curriculum was developed through the following steps.

1. Identification of need for a curriculum for computer literacy for elementary school teachers.
2. Examination through the literature of a broad range of computer literacy topics and goals.
3. Investigation through the literature of factors likely to be related to acquisition of computer knowledge.
4. Identification and development of a theoretical perspective on innovation to provide interpretation of the identified state of computer literacy.
5. Development of a philosophical perspective for curriculum design.
6. Collection of data from the group for whom the curriculum was intended, including attitudes, experience, interests, and intention to learn.
7. Analysis and interpretation of the results of the investigation to identify aims and to guide development of the curriculum content and methods.
8. Preparation of a curriculum characterized by flexible aims, learning through activity, and reflective thinking.

Important components of this approach were an understanding of the existing state of the content area, development of a
theoretical and philosophical approach to the topic, and
preparation of a curriculum that was congruent with the
philosophical approach.

Overview of curriculum. The computer literacy cur-
riculum was developed specifically for the Commodore CBM
8032 microcomputer, 8050 disk drive, and datasette cassette
drive. Educational programs utilized were from Softswap,
available from the San Mateo County Office of Education.
The curriculum could easily be implemented using other
microcomputers, although some modifications in the materials
would be necessary. Because the curriculum depended largely
on teachers using the microcomputers, sufficient micro-
computers were needed to allow all teachers access. The
aims of the curriculum with a brief explanation are pre-
sent below.

1. Learn to operate a simple computer.

Within this aim, the teacher learned to operate
the computer keyboard, to load programs from the
cassette drive and the disk drive. Softswap
programs were loaded and the teacher used the
program in the same way an elementary student
would. After running programs, the teacher com-
pleted a Program Review of each.

2. Understand the steps of a simple program and
explain what a simple program does.

To accomplish this aim, these BASIC commands were
presented: print, let, input, for...next, if...then, read, data, and random numbers. Teachers
completed simple exercises which included enter-
ing programs using these commands. Within this
aim, no attempt was made to prepare the teachers
to write sophisticated programs. Rather, the
teacher learned and used enough BASIC so he
could determine whether he would like more
advanced programming to be included in later steps of the curriculum.

3. Find errors in simple programs.

Teachers corrected errors in programs and then entered and ran programs. The errors were mainly in the BASIC syntax rather than in program logic.

4. Make modifications in simple programs.

Simple educational programs were presented. Teachers made specific modifications in them. The modifications needed were simple and did not require lengthy program modification.

5. Write simple programs to solve a single problem and to solve several similar problems.

The main emphasis in this aim was the desirability of writing programs that had maximum application. Thus, teachers were encouraged to write programs that solved more than one problem. For example, teachers began by writing a program that averaged one student's grades and then built on this program to create one that would allow the teacher to average several students' grades.

Although the main emphasis was on using the computer and writing programs, a secondary emphasis was put on educational uses of computers. This was done by allowing the teachers to run educational programs in the course of learning to operate the computer and by presenting educational programs as examples of programs to be modified or created. Thus, the teachers gained more information and were prepared to make a better informed decision about what additional computer literacy topics would be useful for them.

Recommendations

As was pointed out earlier in this chapter, care should be taken in generalizing the results of this study.
The study was intended to serve as a model for designing curriculum for a specific identified group. In that sense, this study could serve to guide other curriculum designers in the process of tailoring learning aims and activities to a target group. However, because the area of teacher computer literacy is relatively new and uninvestigated, this study brought to light some interesting information that could guide future research.

One area for future research could be guided by the elementary teachers' apparent willingness to accept responsibility for the computer literacy of their students. This suggested elementary teachers were willing to redefine their teaching duties, since computer topics had not generally been a part of the elementary curriculum. A number of questions can be asked. Among these are:

1. What specific computer related skills do teachers believe their students need to learn?

2. Is this willingness to redefine teaching responsibilities limited to the topic of computers? Are teachers likely to agree they have similar responsibilities to teach other relatively new topics?

3. Have teachers considered how use of computers could change their teaching role? Is the willingness to include computers in the curriculum related to some anticipated desirable role change?

4. What theoretical perspectives can be developed to explain this apparent willingness to change?

5. Are elementary school teachers more likely to accept the responsibility for the computer literacy of their students than are middle school teachers and high school teachers?
6. Do teachers actually believe they will ever have to provide computer literacy training for their students? Or do they feel they can express agreement without actually committing themselves to change since computer literacy programs are unlikely to be implemented?

Besides this area of investigation, further research could be undertaken which is related to implementation of the teacher computer literacy curriculum. These questions could be addressed:

1. Are teachers who express commitment and a positive attitude toward learning about computers more likely to participate in inservice training?

2. How do teachers' perceptions of the relative importance of various computer literacy topics change as they learn about computers?

3. Is there any difference in the results of this curriculum and a curriculum developed and organized in some other manner? Can any differences in achievement, attitude, or commitment to further learning be attributed to the type of computer literacy curriculum?

Further attempts to apply the theories of innovation and change could be very useful in explaining and understanding the present state of computers in education. As was pointed out, the anticipated computer revolution in education did not come. Although factors that impede computer use were pointed out by a number of educational writers, very little attempt was made to put these factors into the logical framework of a theoretical perspective. Thus, organizing the present information in terms of how closely it fits a particular theory of innovation could provide insights and suggestions for future direction.
The major purpose of this study, to create a computer literacy curriculum for elementary school teachers, was accomplished. At the same time, a number of related topics for future study arose. The area of computer literacy for teachers is a relatively new one, and much additional study is needed.
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APPENDICES
APPENDIX A
Algorithm
An orderly step-by-step procedure, like a recipe, that consists of a list of instructions for accomplishing a desired result, or for solving a problem. Usually expressed in mathematical terms. In computer programming, an algorithm is expressed as a flowchart.

Computer
A devise that receives and then follows instructions to manipulate information. The set of instructions and the information on which the instructions operate are usually varied from one moment to another. If the instructions cannot be changed, the device is not a computer. The difference between a computer and a programmable calculator is that the computer can manipulate text and numbers; the calculator can manipulate only numbers.

CPU
Central Processing Unit. The heart of the computer, controlling what the computer does. It includes three main sections: arithmetic, control, and logic elements. It performs computations and directs functions of the system.

Data
The information given to or received from a computer.

Hardware
Mechanical, magnetic, electrical, and electronic devices which make up a computer. The physical equipment that goes into a computer system, consisting of the central processing unit plus all peripherals.

Input
Information going into the computer or into a peripheral. The same data may be output from one part of the computer and input to some other part of the computer. When using this word, specify what the data are input to or output from.

Microcomputer

A hardware configuration usually acquired in one of three ways: (1) by constructing several components from individual electronic parts (as in building a stereo system from a kit); (2) by connecting several already-constructed components (as in purchasing a separate amplifier, speaker, and turntable); or (3) by purchasing a unit with built-in components (as in buying a complete stereo system in one package, plugging it in, and using immediately). The end-product of the microcomputer is information. It records this information, processes it, puts it into meaningful terms, communicates it, stores it, and retrieves it when needed. It usually includes the microprocessing unit, a keyboard for entering data, a cassette tape recorder or a disk for storing programs, and a TV-like screen for displaying results.

Microprocessor

An integrated circuit that can execute instructions. It is one component of a microcomputer. It is the brains of the central processing unit (CPU).

Output

Information emanating from a display unit such as a cathode ray tube or printer.

Peripheral Device

A device, such as a printer, mass storage unit, or keyboard, which is an accessory to a microprocessor and which transfers information to and from the microprocessor.

Programming Language

A format by which a programmer can communicate more efficiently with a computer where predetermined commands will yield requested actions. BASIC is one of the most popular languages.

Programs

Series of instructions to a computer which cause the computer to solve a problem or perform a task.

Software

Refers to programs and accompanying documentation. Software is stored on tape cassettes or disks when not being used by the computer. The computer reads the software into its memory in order to use the programs.
COMPUTER LITERACY OBJECTIVES*

MINNESOTA EDUCATIONAL COMPUTING CONSORTIUM

Cognitive

Hardware

H.1.1 Identify the five major components of a computer: input equipment, memory unit, control unit, arithmetic unit, output equipment.

H.1.2 Identify the basic operations of a computer system: input of data or information, processing of data or information, output of data or information.

H.1.3 Distinguish between hardware and software.

H.1.4 Identify how a person can access a computer: for example,
1. via a keyboard terminal
   a. at site of computer
   b. at any distance via telephone lines
2. via punched or marked cards
3. via other magnetic media (tape, diskette)

H.1.5 Recognize the rapid growth of computer hardware since the 1940's.

H.2.1 Determine that the basic components function as an interconnected system under the control of a stored program developed by a person.

H.2.2 Compare computer processing and storage capabilities to the human brain, listing some general similarities and differences.

Programming and Algorithms

Note: The student should be able to accomplish objectives 1.2-2.5 when the algorithm is expressed as a set of English language instructions and is in the form of a computer program.

P.1 Recognize the definition of "algorithm"

P.1.2 Follow and give the correct output of for a simple algorithm.

P.1.3 Given a simple algorithm, explain what it accomplishes (i.e., interpret and generalize).

P.2.1 Modify a simple algorithm to accomplish a new, but related, task.

P.2.2 Detect logic errors in an algorithm.

P.2.3 Correct errors in an improperly functioning algorithm.

P.2.4 Develop an algorithm for solving a specific problem.

P.2.5 Develop an algorithm that can be used to solve a set of similar problems.

Software and Data Processing

S.1.1 Identify the fact that we communicate with computers through a binary code.

S.1.2 Identify the need for data to be organized if it is to be useful.

S.1.3 Identify the fact that information is data that has been given meaning.

S.1.4 Identify the fact that data is a coded mechanism for communication.

S.1.5 Identify the fact that data is the transmission of information via coded messages.

S.1.6 Identify the fact that data processing involves the transformation of data by means of a set of predefined rules.

S.1.7 Recognize that a computer needs instructions to operate.

S.1.8 Recognize that a computer gets instructions from a program written in a programming language.

S.1.9 Recognize that a computer is capable of storing a program and data.

S.1.10 Recognize that computers process data by searching, sorting, deleting, updating, summarizing, moving,
and so on.

S.2.1 Select an appropriate attribute for ordering of data for a particular task.

S.2.2 Design an elementary data structure of a given application (that is, provide order for the data).

Applications

A.1.1 Recognize specific uses of computers in some of the following fields:
   a. medicine
   b. law enforcement
   c. education
   d. engineering
   e. business
   f. transportation
   g. military defense systems
   h. weather prediction
   i. recreation
   j. government
   k. the library
   l. creative arts

A.1.2 Identify the fact that there are many programming languages suitable for a particular application for business or science.

A.1.3 Recognize that the following activities are among the major types of applications of the computer:
   a. information storage and retrieval
   b. simulation and modeling
   c. process control—decision making
   d. computation
   e. data processing

A.1.4 Recognize that computers are generally good at information-processing tasks that benefit from the following:
   a. speed
   b. accuracy
   c. repetition

A.1.5 Recognize that some limiting considerations for using computers are as follows:
   a. cost
   b. software availability
   c. storage capacity

A.1.6 Recognize the basic features of a computerized information system.
Determine how computers can assist the consumer.

Determine how computers can assist in a decision-making process.

Assess the feasibility of potential applications.

Develop a new application.

**Impact**

I.1.1 Distinguish among the following careers:
   a. keypuncher/keyoperator
   b. computer operator
   c. computer programmer
   d. systems analyst
   e. computer scientist

I.1.2 Recognize that computers are used to commit a wide variety of serious crimes, especially stealing money and stealing information.

I.1.3 Recognize that identification codes (numbers) and passwords are a primary means for restricting the use of computer systems, computer programs, and data files.

I.1.4 Recognize that procedures for detecting computer-based crimes are not well developed.

I.1.5 Identify some advantages or disadvantages of a database containing personal information on a large number of people (e.g., the list might include value for research and potential for privacy invasion).

I.1.6 Recognize several regulatory procedures; for example privilege to review one's own file and restrictions on the use of universal personal identifiers that help to insure the integrity of personal data files.

I.1.7 Recognize that most "privacy problems" are characteristic of large information files whether or not they are computerized.

I.1.8 Recognize that computerization both increases and decreases employment.

I.1.9 Recognize that computerization both personalizes and impersonalizes procedures in fields such as education.

I.1.10 Recognize that computerization can lead to both greater independence and dependence on one's tools.
Recognize that, whereas computers do not have the mental capacity that humans do, through techniques such as artificial intelligence, computers have been able to modify their own instruction set and do many of the information-processing tasks that humans do.

Recognize that alleged "computer mistakes" are usually mistakes made by people.

Plan a strategy for tracing and correcting a computer-related error, such as a billing error.

Explain how computers make public surveillance more feasible.

Recognize that even though a person does not go near a computer, he or she is affected indirectly because the society is different in many sectors as a consequence of computerization.

Explain how computers can be used to effect the distribution and use of economic and political power.

Affective

Attitude, Values and Motivation

V.1 Does not feel fear, anxiety, or intimidation from computer experiences.

V.2 Feels confident about his or her ability to use and control computers.

V.3 Values efficient information processing provided that it does not neglect accuracy, the protection of individual rights, and social needs.

V.4 Values computerization of routine tasks so long as it frees people to engage in other activities and is not done as an end in itself.

V.5 Values increased communication and availability of information made possible through computer use provided that it does not violate personal rights to privacy and accuracy of personal data.

V.6 Values economic benefits of computerization for a society.

V.7 Enjoys and desires work or play with computers,
especially computer-assisted learning.

V.8 Describes past experiences with computers with positive-affect words, like fun, exciting, challenging, and so on.

V.9 Given an opportunity, spends some free time using a computer.
COMPUTER SURVEY: TEACHERS

1. School _______________________

2. Check one:
   __ Teacher, grade(s):
   __ Specialist, indicate specialty
   __ Other

3. __ Fax

4. __ Years of teaching experience

5. __ Approximate number of college level mathematics courses taken.

6. Have you attended any workshops or courses on the use of computers in education?
   __ No
   __ Yes. (Please describe briefly)

7. Have you ever used a computer?
   __ No
   __ Yes, I have used a computer in my own classroom.
   __ Yes, but not in my own classroom.
   __ (Please describe)

8. Below are statements about computers. Please indicate how you feel about the statement.

   __ We teachers have a responsibility to prepare students to live in a computer oriented society.
   __ I could really learn to use a computer.
   __ Using computers in my classroom would keep my students from learning new basic skills.
   __ Computers will never really replace teachers.
   __ Computers are becoming increasingly effective at teaching students.
   __ The use of computers in education is just a passing fad.
   __ My class would be easier to discipline and control if I had computers in my classroom.
   __ Using computers will make it easier to meet students' individual needs.
   __ It would be more trouble than help to have a computer in my classroom.
   __ Computers democratize education.

9. Please indicate under what conditions you would attend a training session on computers. Check all answers that apply.

   __ Yes
   __ Available only at your own expense
   __ During school hours and you were released from your class
   __ On your own time
   __ A one-day session
   __ A week-long session
   __ A semester-long college course
Below is a list of computer related skills teachers can learn. Because you may not be familiar with some of the terminology, here is a brief explanation of the terms used:

**HARDWARE** - the computer and the other physical equipment of a computer system.

**SOFTWARE** - the instructions that direct the computer, usually stored on magnetic tape or disk.

**PROGRAM** - same as **SOFTWARE**; instructions that determine what the computer does.

**ALGORITHM** - an outline of a computer program in a series of logical steps.

**PROGRAMMING LANGUAGE** - a language used to communicate with a computer, made up of specific commands that the computer can execute.

There are many topics that can be included in teaching about computers. If the district develops an Inservice for teachers, some of the topics listed below would be taught. Please indicate how important you believe each item is for teachers to learn.

<table>
<thead>
<tr>
<th>Item</th>
<th>Very Important</th>
<th>Moderately Important</th>
<th>Not Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learn what happens inside a computer when it operates.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Know the major parts and functions of the hardware in a computer system.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learn criteria for selecting hardware.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify several ways that computers receive information.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understand how a computer processes information.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understand the difference between computer hardware and software.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learn the history of computers.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learn how the human brain and a computer are alike and are different.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learn to operate a simple computer.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Be able to explain what a computer algorithm is.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understand the steps of a simple program.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain what a simple program does.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make modifications in a simple program.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Find errors in a simple program.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write a simple program to solve one problem.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write a simple program to solve several similar problems.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Know how computers store information.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Know how to organize information a computer could use it.</td>
<td></td>
<td></td>
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<tr>
<td>Understand why computers need programs.</td>
<td></td>
<td></td>
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<tr>
<td>Use computer programs prepared by others.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine the usefulness of a given computer program.</td>
<td></td>
<td></td>
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<tr>
<td>Evaluate the quality of a given computer program.</td>
<td></td>
<td></td>
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<tr>
<td>Know the major uses of computers in education.</td>
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<tr>
<td>Learn about different programming languages used in education.</td>
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<tr>
<td>Know factors that limit educational uses of computers.</td>
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<tr>
<td>Examine new applications of computers in education.</td>
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<tr>
<td>Develop new applications of computers in education.</td>
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<tr>
<td>Examine the effects of computers on society outside the educational setting.</td>
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<tr>
<td>Examine how computers may personality or impersonalize education.</td>
<td></td>
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</tr>
<tr>
<td>Consider whether computers make individuals more or less independent on their job activities.</td>
<td></td>
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</table>

Thank you very much for your cooperation in completing this survey. We appreciate the time you have given us.
APPENDIX D
<table>
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<td>Factor Three</td>
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## MULTIPLE REGRESSION

**COMPUTER LITERACY TOPICS PREDICTING COMMITMENT TO LEARNING ABOUT COMPUTERS**

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Total Multiple R Square = 0.44783

**Significant at .01**

*Significant at .10*
MULTIPLE REGRESSION

COMPUTER LITERACY TOPICS PREDICTING ATTITUDE TOWARD COMPUTERS

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Total Multiple R Square = 0.40495

**Significant at .01
*Significant at .10
This curriculum is designed to be implemented as an inservice program for elementary school teachers. Each teacher should have access to the following:

1. Commodore CBM 8032 microcomputer
2. Commodore 8050 disk drive
3. Commodore datasette cassette drive
4. Softswap Dissemination Disk #1, available from: San Mateo Office of Education 33 Main Street Redwood City, CA 94063
5. Softswap programs on tape
6. Resource books:


LESSON ONE
OPERATING A COMPUTER

The purpose of this lesson is to familiarize you with the computer system you will be using. You will need these materials:

1. Commodore CBM 8032 microcomputer
2. Commodore 8050 disk drive
3. Commodore datasette cassette drive
4. Softswap Dissemination Disk #1
5. Softswap cassette
6. Resource book:

A. Turning the computer on.

The switches and connectors are on the back of the computer. The power switch is on the left side as you face the computer. Turn the computer on.

When the computer is turned on, you will see this on the screen:

***commodore basic 4.0***
3174 bytes free
ready
Below the word "ready" is a flashing rectangle, called the cursor. The screen message indicates the computer is ready for operation.

B. Using the Keyboard

Now type your name. The keyboard operates in the same general way as a typewriter. When you press a key, the letter on the key is displayed on the screen. You may type capital letters by holding down the SHIFT key while you press the letter key.

Cursor Keys

Notice that the cursor moves as you type, staying just to the right of the last letter you typed. The cursor may also be moved without typing letters. This is done with either of these two keys:

![Cursor Keys Diagram]

Press the CRSR (left/right) key several times. Notice what happens. Type a word. Notice where it is displayed. Now hold down the SHIFT key and press the CRSR (left/right) key again. What happens now? Experiment in the same way with the CRSR (up/down) key. When you feel you understand the function of the CRSR keys, go to the next section.

Clear/Home Key

Now press the key marked CLR/HOME. Where does the cursor go? This position on the screen, the upper left corner, is called HOME. You can move the cursor from any place on the screen to HOME by pressing the CLR/HOME key. Now hold down the SHIFT key and press CLR/HOME. What happens? You can see that CLR is an abbreviation for CLEAR, so when you press SHIFT and this key you can clear the screen of all but the cursor. Take some time now to type things on the screen, move the cursor around, type some more, and then clear the screen.

Insert/Delete Key

Type this phrase: The sky is blue.

Find the INST/DEL key and press it. What happens? Press it again and see where the cursor goes. Continue to press the key until the entire word "blue" is gone. Can you tell now what the function of the DEL key is?
Now type the word "gray" where "blue was. Then use the CRSR (left/right) key to put the cursor on the letter "g" in "gray." Now hold down the SHIFT key and press the INST/DEL key four times. What happens? You should now have four extra blank spaces between "is" and "gray." Type the word "not" in the blank spaces and use the CRSR (left/right) to move the cursor to the end of the sentence.

You may have realized by now that DEL is an abbreviation for "delete" and INST is an abbreviation for "insert." These keys make it easy to add or subtract from words and sentences without having to type the entire line over.

Review

You have now used a number of the different keys on the CBM keyboard. See if you can remember the functions of these keys.

<table>
<thead>
<tr>
<th>Key</th>
<th>function without SHIFT</th>
<th>function with SHIFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRSR(left/right)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRSR(up/down)</td>
<td></td>
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<tr>
<td>CLR/HOME</td>
<td></td>
<td></td>
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<tr>
<td>INST/DEL</td>
<td></td>
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</tbody>
</table>

If you can't readily answer these, practice with the keys until you feel sure you know their functions. Then go on to the next paragraph.

C. Using the Cassette Drive

Notice that the cassette drive is plugged into the computer on the back right side. The cassette player does not have to be turned on separately. As long as the computer is turned on, the cassette drive is ready. Get the Softswap cassette tape and do the following:

1. Open the cassette drive by pressing the STOP/EJECT button.

2. Put the cassette in, label side up. The exposed magnetic tape is facing you.
3. Press the REW button on the cassette drive to rewind the tape.

4. Type LOAD on the keyboard and press the RETURN key. The computer will respond with this message:
   press play on tape #1

5. Press the PLAY button on the cassette drive. The computer will respond with this message:
   ok
   searching
   found program name
   loading
   ready
   It may take several minutes for the computer to find and load the program. Be patient and watch the screen to see if the computer displays the message above.

6. Type RUN and press RETURN on the keyboard.
   The program will begin. Use the program as if you were an elementary school student using this educational program. Answer all questions it asks you. Just to explore the program, answer some questions incorrectly to see what type of response you are given. When the program has finished, fill out one of the Program Review forms included with this lesson.

7. To load and run another program, first type NEW and press the RETURN key. This removes the previous program from the computer's memory. Now go back to Step 4 in these instructions and proceed from there. DO NOT rewind the tape or you will load in the first program again. Complete another Program Review form when the program is finished.

D. Using the Disk Drive

Notice that the disk drive is connected to the computer on the back in the middle. The disk drive must be switched on. The switch is on the back left side of the disk drive. Make sure the computer is turned on and no disks are already in the disk drive. If any are, take them out. Turn on the disk drive and get the Softswap Disk #1. Then do this:
1. Take the diskette out of its thin paper envelope. Do not attempt to take the disk out of its black protective plastic jacket. Hold the disk by the label on the plastic jacket, being careful not to touch the exposed parts of the disk which are visible through holes in the jacket.

2. Gently slip the diskette label side up into the slot in the front of the disk drive which is labelled Drive 0. When the diskette is properly inserted you will hear a click. If it does not slide in easily, pull it out and try again.

3. Press down on the door of the disk drive to close it.

4. On the computer keyboard, press the SHIFT and RUN/STOP keys simultaneously. This causes the disk drive to begin operation and load the program from the diskette.

5. When the program is loaded, it will display a menu of programs. Select one as indicated on the screen. When the computer displays the READY message, type RUN and press RETURN.

6. Interact with the program. When it has finished, complete a Program Review form.

7. Press the SHIFT and RUN/STOP keys to load the menu again. Proceed through Steps 5 and 6.

E. Turning Off the System

To avoid damaging the diskettes, it is important to remove them before turning off and on the equipment.

1. Remove any diskettes and return them to their envelopes. Always put them away promptly.

2. Turn off the disk drive.

3. Turn off the computer.

This completes the first lesson. If you would like to know more about the computer, refer to the PET/CBM Personal Computer Guide.
PROGRAM REVIEW FORM

Name________________________________________

Program Name________________________________

Date________________________________________

On what skill does this program focus?

For what grade or grade levels is this program appropriate?

Would this program be especially useful for a particular group of students? If yes, please describe the student group and indicate why it would be useful.

Are there students for whom you would not recommend this program be used? If yes, please describe the type of student and indicate why you would not recommend it.

How does the program respond when you give a correct answer?

How does the program respond when you give an incorrect answer?

Is it possible to deliberately or inadvertently interrupt the running of the program? How?
Would this program be useful as it is for your students? If not, how could it be changed to make it more useful?

What did you like about the program?

What did you dislike about the program?

Can you foresee any problems students might have with this program?

Do you think your students would enjoy using this program?

Would your students learn from this program?

Additional comments...
LESSON TWO
PROGRAMMING: PRINT COMMAND

The purpose of this lesson is to introduce you to the BASIC programming language. You will practice using the PRINT command. You will need these materials:

1. Commodore CBM 8032 computer
2. Resource book:

A. Turn on the Computer.

B. Type this:
   My name is John.
   Press RETURN.

What happens? Does the computer appear to understand what you entered? (Note: "enter" means to type some words and then press RETURN. Pressing RETURN sends your message to the computer.

SYNTAX ERROR indicates that the computer was unable to understand the message it received. The computer has a very limited vocabulary and only understands some words.

C. Now type this:
   10 print "My name is John."
   Press RETURN.

What response did you receive from the computer? If you typed the line exactly as it is written above, the computer did not send you any message, and the cursor moved down to the next line.

If the computer responded with a SYNTAX ERROR message or did anything besides just move the cursor to the next line,
compare your line with the one above. You've made some
typing error, so just type the line over and enter it again.

Now type RUN and press RETURN.

What happens? If the computer display looks like this you have successfully created a BASIC program:

```
10 print "My name is John."
run
My name is John.
ready
```

If your display does not look like this, go back to the
beginning of Step C and start over.

Compare the line you entered in Step B with the line you entered in this step. What are the differences? These differences are what makes one a program and one not. Notice the line in Step C has these parts that the line in Step B did not:

- It has a line number. (It is line 10.)
- It has a BASIC command. (Print is in the computer's vocabulary.)

D. Clear the screen by pressing SHIFT and CLR/HOME.

Type RUN and press RETURN.

What happens? Even though you cleared the screen, your program stayed in the computer's memory.

E. Type LIST and press RETURN.

LIST is a way to see the program lines. What is the difference between LIST and RUN? If you are not sure, RUN and LIST your program several times until you see the difference.

```
RUN executes the program.
LIST displays the program lines.
```

F. Type NEW and press RETURN.

Now try to RUN and LIST your program. What happens? NEW is a command that causes the computer to erase your program from its memory.

G. Enter this program. ("To enter" the program means to type one line at a time, pressing return at the end of each
Now RUN the program. Notice how it is displayed on the screen. Each word is printed on a separate line.

H. Add a line to your program in this way. On the line where the cursor is right now, type and enter:

25 print"a lot of"

LIST the program. Notice the order of the lines. You can modify a program by adding new lines with new line numbers. The computer will put them in order according to the line numbers you use.

RUN the program. Pay close attention to the display.

I. Now remove the program from the computer's memory by entering NEW. Then enter this program:

10 print 5+6
20 print 10-3
30 print"5+6"
40 print"10-3"

Before you RUN the program, see if you can guess what each line will do. Then RUN the program to see if you guessed correctly.

What does line 10 cause to be displayed?
What does line 30 cause to be displayed?
How are they different?

You see that you can cause the computer to computer a numerical expression and print it by omitting quotation marks. However, if the numerical expression is enclosed in quotation marks the computer makes no attempt to computer the value.

J. In the programs you have written so far, each PRINT command causes a separate line of words or numbers to be printed. The following program is different. Erase the old program by entering NEW. Enter this program. Be sure to include blanks as shown inside the quotation marks.

10 print"we ";
20 print"like ";
30 print"to use ";
40 print"computers."
RUN the program.

What is the function of the semicolon? The semicolon causes the text within the quotation marks to be printed on the same line with no spaces between them.

Change the semicolons to commas. Make the changes by LIST-ing the program, then using the cursor control keys, CRSR (left/right) and CRST (up/down) to move up into the program. Position the cursor on the semicolon in line 10, type a comma, and press RETURN. Do the same for lines 20 and 30. Then move the cursor to the line below READY and LIST the program. The program now has commas at the ends of the lines instead of semicolons.

Now RUN the program. How is the display different with commas rather than with semicolons? The comma causes the text to be printed in blocks of ten spaces.

K. These terms are important. Do you remember what they mean?

PRINT
line number
RUN
LIST
SYNTAX ERROR

If you are not able to define these or are not sure why they are important, look back through this lesson. Here is a review of the important points in this lesson:

1. Program lines must have line numbers. The computer executes lines sequentially.

2. PRINT is a BASIC command that causes something to be displayed on the screen.

If the information following the PRINT command is enclosed in quotation marks, the computer displays it exactly as it was entered.

If a numerical expression with no quotation marks follows the PRINT command the computer determines the correct answer and displays it. For example:

This PRINT statement............causes this display.

10 print"hello" hello
20 print"4+ll" 4+11
30 print 5+13 18
3. The RUN command causes the computer to execute the program.

4. The LIST command causes the computer to display the lines of the program.

5. SYNTAX ERROR indicates the computer is unable to interpret a message sent to it.

6. the NEW command erases the current program.

L. You are now ready to write some simple programs. Try the following:

1. Write a program that prints your name on one line, your address on the next line, and your telephone number on the third line.

2. Write a program that prints an addition problem on one line and its answer on the second line. Make the computer calculate the answer on the second line.

3. Explain what this program will do when executed. Enter and run the program to check your accuracy.

10 print"A dozen is ";
15 print 18-6
20 print"But a baker's dozen ";
25 print"is",
30 print 2+3-4+20-8
SAMPLE ANSWERS FOR LESSON TWO

1. 10 print"Charles Smith"
   20 print"2315 Pershing Ave., Stockton"
   30 print"466-2222"

2. 10 print"The sum of 23 and 40 is"
   20 print 56-18

3. This program will print the following:

   A dozen is 12
   But a baker's dozen is 13
LESSON THREE
PROGRAMMING: INPUT AND GOTO

The purpose of this lesson is to extend your grasp of the BASIC language. In the last lesson you learned the use of the PRINT command as well as the use of RUN, LIST, and NEW. This lesson builds on that knowledge and adds two new BASIC commands, INPUT and GOTO. You will also learn about VARIABLES. You need these materials:

1. Commodore CBM 8032 microcomputer
2. Resource book:

A. Turn on the computer or type NEW to erase any program in memory.

B. Enter this program:

   10 print"Hello",
   20 goto 10

Before you RUN the program, try to imagine what the program will do.

Now RUN the program. After several seconds, press the RUN/STOP key.

LIST the program. Look at it and see if you can determine what causes the program to go on and on without stopping. Would the program ever stop by itself?

In this program, line 20 causes a loop in the program. As soon as the computer executes line 10 and prints "Hello" the program goes to line 20. This sends it back to line 10.

The BASIC command GOTO allows the programmer to determine which statement will be executed next.
C. Type NEW and enter this program.

```
10 print "hello",
20 goto 40
30 print "Computer",
40 print "Everybody"
```

What do you think will happen? RUN the program to see if you are right. Why isn't line 30 executed? Because line 20 determines that line 40 will be executed next, line 30 is skipped.

D. Type NEW and enter this program.

```
10 print "What is your name?"
20 input n$
30 print n$
```

Check to make sure you have typed the program exactly as shown. Then RUN the program.

Line 20 causes two things to happen. First, it makes the program pause and wait for the user to enter information. Second, it causes the computer to set aside a place in its memory that it names n$ (pronounced "n-string"). When the user enters his name the computer stores it at the place in memory that it has called n$.

n$ is a variable. It can be different each time you run the program.

RUN the program again. After the question, "What is your name?" is displayed, wait for several seconds. Notice that the program does not continue. Now enter some nonsense word as your name. Note that the computer accepts anything you enter. It does not evaluate the word you enter to see if it is a name, but rather just stores it in n$.

E. Now expand this program by adding these lines:

```
40 print "How old are you?"
50 input y
60 print y
```

You add these lines by typing them in where the cursor is, under the word READY. Because each line begins with a number, the computer interprets it as a program line and adds it to the program.

LIST the program. Notice that in line 20 you typed the variable name as "n$" but in line 50 you left of the #$ sign and typed the other variable as "y." This is because there are two types of variables:
n$ is a string variable. This means the computer considers n$ to be a word of some sort. You can have numbers stored in string variables, but the computer "thinks" of them as words and will not be able to perform mathematical operations with them.

y is a numeric variable. Naming the variable without a "$" sign indicates you intend to store numbers. ONLY numbers can be stored in numeric variables. If you try to enter a word, the computer will respond by sending you this message: REDO FROM START. The program will not continue until a number is entered.

In the description above, the variables were named n$ and y. These are just examples of variable names. As you write programs you can make up your own names for variables.

Now RUN the program. Answer the first question with a word and the second with a number.

RUN the program again. Answer both questions with numbers. What happens?

RUN the program a third time. Answer both questions with words. What happens?

The three program runs you just did should show you this: if a variable is declared to be a string variable, numbers or letters can be entered. However, if a variable is declared to be a numeric variable ONLY numbers can be entered.

F. Add this line to the program:

    70 print n$;" you are";y;"years old."

RUN the program.

Notice how variables are interspersed in the PRINT statement. The semicolons separate the variables from the part of the PRINT statement that is in quotation marks.

G. Review these terms:

    GOTO directs the execution of the program.

    INPUT requires the user to enter information and allocates a place in memory to store this information.

    VARIABLE is the name for a location in memory where information can be stored. Words or numbers can be stored as variables.
H. Write these programs:

1. Print your name continuously using a loop. Stop the program with the RUN/STOP key.

2. Ask the user to enter the day of the month, then the name of the month, then the year. Store this information in variables. Then print, based on the information entered, a sentence like this:

   Today's date is December 10, 1082.
SAMPLE ANSWERS FOR LESSON THREE

1. 10 print"Mary Worth"
   20 goto 10

2. 10 print"Please enter today's date."
   20 print"First give me the day of the month."
   30 input d
   40 print"Next give me the name of the month."
   50 input m$
   60 print"And now give me the year."
   70 input y
   80 print"Today's date is ";m$;d;",";y;"."
LESSON FOUR
PROGRAMMING: FOR...NEXT, IF...THEN

This lesson focuses on two sets of BASIC commands, FOR...NEXT and IF...THEN. The LET command is also introduced. These materials are needed:

1. Commodore CBM 8032 microcomputer
2. Resource book:


A. Turn on the computer or type NEW to erase any program in the computer memory.

B. Enter this program:

```
10 for x=1 to 8
20 print"Hello",
30 next x
40 end
```

Notice END is put in the program to indicate the last line. RUN the program.

How many times is "Hello" printed? Change the 8 in line 10 to 15 so the line reads:

```
10 for x=1 to 15
```

RUN the program again. What is the difference? FOR...NEXT causes a loop in a program. The number of times the loop is executed depends on the values in the FOR statement.

C. Modify the program so that it has this line:

```
25 print"x is";x
```

RUN the program. This time you can see how the value of x changes. It starts at 1 and increases by increments of one until x is 15. Change line 10 to:

```
10 for x=1 to 6
```
RUN the program again. Note how the value of x changes.

D. To make this operation of the loop more clear, a variable whose purpose is to count the loops can be added. This is done in the following lines:

```
5 let c=0
12 c=c+1
13 print"loop ";c
```

Add these lines to the program. LIST the program to see how these lines fit into the program. Notice the variable is created in line 5 and set at 0. This is done before the FOR...NEXT loop begins. The variable c serves as a counter, so every time a loop is executed the value of c increases by one.

Now RUN the program. This time you can see that for each loop, the value of x increases by one.

E. In the program as it is now, x increases by one in each loop. You can control the amount by which x increases. Change line 10 to:

```
10 for x=1 to 15 step 2
```

RUN this program. Notice that the message is printed only eight times. You control the change in the value of x by increasing it by two each time it goes through the loop. Experiment with line 10. Change it to:

```
10 for x=10 to 1 step -1
```

RUN this and observe the change in x. Practice with this until you feel sure you understand the function of FOR...NEXT.

F. Type NEW to erase the program.

Now you will enter a program with a new BASIC command:

```
10 print"Do you like to program?"
15 print"Answer yes or no."
20 input a$
25 if a$="yes" then print"I do too."
30 if a$="no" then print"Why not?"
40 end
```

Using the IF...THEN command you can examine the word entered and cause different responses to be printed to correspond with the different answers.

RUN the program. What happens if you enter some answer
other than yes or not? If you answer "I don't know," then neither line 25 nor line 30 is executed, and the program ends without printing a response.

G. Here is an example of a way the IF...THEN command is used. Type NEW and enter this program:

```
10 print"What is the capitol of California?"
15 input c$
20 if c$="Sacramento" then 50
25 print"Try again."
30 goto 10
50 print very good!" You're right."
200 end
```

Before you run the program, walk through it line by line to see if you can tell what the program does. Now RUN the program. Try it several times, entering a number of incorrect answers as well as the correct answer. Do you understand why the program goes back to line 10 if a wrong answer is entered? If the answer entered is "Sacramento" then the computer executes line 50. If the answer is anything but "Sacramento" then lines 25 and 30 are executed. Line 30 causes the program to go back to line 10.

H. The program above can be extended to ask a second similar question after the first is answered correctly. Add these lines:

```
55 print"What is the capitol of Washington?"
60 input c$
65 if c$="Olympia" then 80
70 print"Try again."
75 goto 55
80 print"Good work. That is right."
```

RUN the program. You now have the basic structure of a drill and practice program. Notice that the two parts of the program, lines 10-50 and lines 55-80, are nearly identical except for the question and answer. An efficient program would use a different programming technique to avoid repetition as in this program. You'll see a more efficient program in the lesson on READ and DATA. For now, the above program is acceptable.

I. Review these BASIC commands you used in this lesson.

FOR...NEXT. This sets up a loop in the program. The programmer controls the number of times the loop is executed. Each time FOR is used NEXT must also be used.

IF...THEN. This causes the computer to check to see if a particular condition is true, then directs execution
of the program to different lines based on whether the condition is true or false.

If you are not certain you understand the use of these commands, review the programs presented in this lesson and use the resource book, *A Bit of BASIC*.

**J. Practice Exercises**

1. Using a FOR...NEXT loop, print the message "Good work!" to fill up the whole screen.

2. Using the IF...THEN command, ask the user three questions. Do not allow the student to go on to the next question until the correct answer is given. Vary the comments made when a correct answer is entered.

3. Using the program listed in Step G, add a counter to keep track of how many tries it takes the student to get the correct answer. Add a line that tells the student how many tries he needed to get the answer right.

4. Find the errors in these programs.

**A.**

```basic
10 for b=1 to 10
20 print"Good!"
30 next x
40 end
```

**B.**

```basic
10 print"Do you like math?"
15 input a
20 if a="yes" then print "So do I."
30 if a="no" then print"Why not?"
40 end
```

**C.**

```basic
10 print"Is it a windy day?"
20 if a$="yes" then print"Is is too windy?"
25 if a$="no" then print"It is a calm day."
30 end
```
SAMPLE ANSWERS FOR LESSON FOUR

1. 10 for x=1 to 200
   20 print"Good work!",
   30 next x
   40 end

2. 10 print"What ocean is to the west of California?"
   15 input o$
   20 if o$="Pacific Ocean" then 50
   25 print"Try again, please."
   30 goto 10
   50 print"You're correct. Pacific Ocean is right."
   60 print"What country is on California's southern border?"
   65 input c$
   70 if c$="Mexico" then 100
   75 print"Sorry, that's incorrect. Try again."
   80 goto 60
   100 print"Mexico is correct."
   110 print"What state borders California on the north?"
   120 input s$
   130 if s$="Oregon" then 160
   140 print"Try that one again. Your answer is wrong."
   150 goto 110
   160 print"Yes, Oregon is on California's north. Good."
   170 end

3. 5 let c=0
   10 print"What is the capital of California?"
   15 input c$
   17 c=c+1
   20 if c$="Sacramento" then 50
   25 print"Try again."
   30 goto 10
   50 print"Very good. You're right."
   55 print"This is how many tries you needed:";c
   200 end

4. A. The FOR line uses the variable b but the NEXT line uses x.
   B. The variable is declared numeric, but answers are words.
   C. The input line is left out.
LESSON FIVE
PROGRAMMING: RANDOM NUMBERS

Lesson Five introduces the random number function. This allows the computer to select numbers for you, which can be useful in a number of situations. For example, if you have a class of 30 students and you wish to pick one of them at random, you can do the following. Assign each of the students a number by having them count off from 1 to 30. Then cause the computer to randomly select a number from 1 to 30 for you. For this lesson on random numbers, you will need these materials:

1. Commodore CBM 8032 computer
2. Resource book:


A. Turn on the computer or type NEW to erase any programs in the computer memory.

B. Enter this program:

```
5 for c=1 to 20
10 let x=int(rnd(1)*10+1)
15 print x;
20 next c
```

For now, don't be too concerned with the exact meaning of the expression in line 10, which is the random number function. Just carefully enter the program. RUN the program several times. What is the largest number generated? What is the smallest? Line 10 controls the maximum and minimum numbers generated, which in this case are 10 and 1. Change line 10 to:

```
10 let x=int(rnd(1)*20+1)
```
RUN this version of the program several times until you can say with certainty what are the largest and smallest numbers generated. The largest is 20 and the smallest is 1.

B. Random numbers are frequently used in math drill and practice programs. The following is a program that creates five addition problems. The numbers added together are between 1 and 20.

```
10 for c=1 to 5
15 let x=int(rnd(1)*20+1)
20 let y=int(rnd(1)*20+1)
25 print x;"+";y;"= ?"
30 input a
35 if a=x+y then 50
40 print"Sorry, try again."
45 goto 25
50 print"Correct. Good work."
55 next c
60 end
```

RUN the program several times. Be sure you understand how it works.

C. To make the addition problems more difficult, the program can be changed to include numbers from 1 to 50. In that case, lines 15 and 20 would be:

```
15 let x=int(rnd(1)*50+1)
20 let y=int(rnd(1)*50+1)
```

Enter these lines and RUN the program several times.

D. Modify the program so that it prints three problems rather than five. This is done by changing line 10 to:

```
10 for c=1 to 3
```

RUN the program several times.

E. Exercise

Write a program like the one in Step B. Make it a multiplication drill for numbers from 1 to 10. Have it generate 6 problems.
10 for c=1 to 6
15 let x=int(rnd(1)*10+1)
20 let y=int(rnd(1)*10+1)
25 print x;"times";y;"= ?"
30 input a
35 if a=x*y then 50
40 print"try again. Your answer was incorrect."
45 goto 25
50 print"right!"
55 next c
60 end
Lesson Six focuses on the BASIC commands READ and DATA. These commands allow information to be stored within the program and to be used at the direction of the program.

These materials are needed:

1. Commodore CMB 8032 microcomputer
2. Resource book:


A. In Lesson Four you wrote a program that asked the student a question, waited for the answer, and then checked to see if the answer was correct. At that time it was pointed out that a more efficient program could be written using READ and DATA commands. The following program accomplishes the same purpose as the program given in Lesson Four:

```
10 print"Please answer the following questions."
12 for i=1 to 5
15 read s$,c$
20 print"What is the capitol of ":s$;"?"
25 input a$
30 if a$=c$ then 50
35 print"Sorry. Try again."
40 goto 20
50 print"Correct. Good Work."
55 next i
70 data "California","Sacramento"
75 data "Washington","Olympia"
80 data "Oregon","Salem"
85 data "Nevada","Carson City"
90 data "Colorado","Denver"
100 end
```

RUN the program. Enter some incorrect answers. This program could be modified to include all fifty states by adding more data statements. The information in each data line is entered in memory as s$ and c$ by line 15. The READ command causes the computer to look for DATA lines in the program. The READ command in line 15 tells the computer to read two pieces of data, so it reads the first two it finds. Then as
it encounters the READ command again, it reads the next two.

B. DATA and READ commands are often used to set up multiple choice problems. See if you can tell what this program does:

```
5 print "here are two multiple choice questions."
10 print "Please indicate your choice by typing"
15 print "the letter to the left of the answer."
20 print
22 for c=1 to 2
25 read q$, al$, a2$, a3$, c$, r$
27 print
30 print q$
35 print a" ; al$
40 print b" ; a2$
45 print c" ; a3$
50 input a$
55 if a$=c$ then 80
60 goto 55
65 print "Try again."
70 goto 55
80 print r$
85 next c
90 data "What is the Capitol of California?"
95 data "San Francisco", "Sacramento"
100 data "Los Angeles", "b", "You are correct."
105 data "What is the capital of Oregon?", "Portland"
110 data "Eugene", "Salem", "c"
115 data "You're correct. Good work."
120 end
```

It will help you understand what goes on in this program if you know what the variables stand for. Here is a list of the variables:

- **c**: counter in the FOR...NEXT loop
- **q$**: the question to be asked
- **al$**: the first multiple choice answer
- **a2$**: the second multiple choice answer
- **a3$**: the third multiple choice answer
- **c$**: the letter to the left of the correct choice
- **r$**: response to print when the answer given is right
- **a$**: the user's response to the question

RUN the program. You will probably find that you've made some errors in typing that will need to be corrected before the program will run. Don't be discouraged: it's very hard to avoid making errors. After you've successfully run the program several times, LIST the program again. Read through it until you feel sure you understand how it operates.
C. Exercises

1. Using the first program in this lesson as a model, write a program that uses READ and DATA commands to ask a series of questions. Ask questions that can all fit into the same format, as shown in that program.

2. Using the second program in this lesson as a model, write a multiple choice program. Set the program up with enough data so it asks five questions, and so a different comment is made after the correct answer for each question. Remember, if you put in enough data for five questions, you will need to change the counter in the FOR...NEXT loop to 5.
NOTES ON STATISTICAL PROCEDURES

Reliability

The measures of attitude, commitment, and three computer literacy factors were created by summing individual ordinal survey items. The reliability of the scales was assessed with Cronbach's alpha, which expresses the expected correlation between the existing scale and a hypothetical alternative form of the same scale. Cronbach's alpha is considered a conservative estimate of reliability. A reliability of at least .80 is suggested for widely used scales.*

Correlations

Spearman's rho was used to measure the correlation between attitude and: 1) number of college math courses and 2) number of years of teaching. This measure was used because it is intended for ranked data.**

Multiple Regression

Multiple regression analysis is a method of analyzing a problem with more than one independent variable. Correlations between computer literacy topics (independent variables) and: 1) attitude (dependent variable) and 2) commitment to learning (dependent variable) were assessed. Multiple regression is intended for use with a continuous dependent variable and continuous or discrete independent variables. A multiple regression coefficient is calculated which indicates the amount of increase or decrease in the dependent variable for every one-unit change in the independent variable.** However, both the dependent and independent variables were discrete. Thus the standardized regression coefficient (beta) may be inaccurate. However, the major purpose of this analysis was to determine which independent variables were significantly correlated with the dependent variable, and this is accurate.
