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ABSTRACT

This publication discusses computer education for teachers, reports the results of a nationwide survey on what teacher training institutions are doing about computer education, and looks into computer education trends in American school districts. Additionally, results are briefly discussed of a national survey of superintendents' attitudes concerning the role of the computer in the classroom and the training of teachers using computers for instruction. An annotated bibliography on the use of computers in education is included. (DT)

Fastback 82

Computers in the Curriculum

Justine Baker

PHI DELTA KAPPA EDUCATIONAL FOUNDATION

JUSTINE C. BAKER

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COMPUTERS IN THE CURRICULUM

By Justine Baker

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TABLE OF CONTENTS

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6

INTRODUCTION

COMPUTERS ARE FOR KIDS was the motto advanced by Digital Equipment Corporation, a leading manufacturer in the field of interactive instructional computers. Faithful to a commitment in educational computing, they have published journals featuring heart-warming excerpts about how computers sparked elementary and secondary school pupils into enthusiastic learners. Recently, however, the word *kids* was replaced; the motto now reads: *COMPUTERS ARE FOR EVERYONE.*

The latter premise will be used subsequently as an endorsement for the theme of this essay: "Computers are for teachers," meaning instructors in elementary and secondary schools. It is the author's conviction, based on research, that not enough is being done in American colleges of education to teach prospective and practicing teachers about computers and their instructional applications. If computers are for everyone, they must be for teachers!

Computer education for teachers surfaced in the mid-1960s. By the early seventies several important documents were published and alerted educators to the need for computer training. The *Report of the President's Science Advisory Committee* to The White House on *Computers in Higher Education* appeared in February, 1967. In an appendix to that report, H. O. Pollak, director of mathematics and statistics research at Bell Telephone Laboratories, mentioned the need for prospective secondary mathematics teachers to study in college about computers and their applications. Citing the facts that all curricular reforms planned for secondary mathematics involved the use of computers and that texts for a high school computing course had just been published, Pollak justified his concern and that of other mathematicians about computer education for teachers.

In 1970 Ernest Anastasio and Judith Morgan conducted a study based on the Delphi technique and a follow-up conference for the authorities who had participated in their research project. Several reasons were cited as responsible for obstructing both numbers and uses of computers in instruction. Among the inhibiting factors were teacher anxieties about handling computer equipment, preparing computer-based learning materials, and, in general, effectively teaching with the aid of computers. Other concerns, such as being deprived of highly valued personal relationships with students and even being replaced by computers, were also expressed.

A major recommendation was that teacher training institutions should be funded to design and implement action courses in which teachers could learn about computers, have firsthand experiences, and develop positive attitudes and practical methods for integrating computer-based learning activities into their tradition-oriented classrooms.

Two other studies, both published in 1972, awakened educators to the problems facing teachers in light of "the fourth revolution," as one report termed the introduction of technological devices to education. The Carnegie Commission on Higher Education took a futuristic stance on computers in education. Using a normative approach to forecasting, the Carnegie team projected that in 2000 A.D. instructional technology would be in general use in schools and colleges throughout America. Given 2000 as a target date for full-scale acceptance of technological achievements in education, the commission anticipated by 1980 all colleges and universities responsible for training prospective high school teachers and college professors should offer courses in instructional technology. Certainly courses about computers would fit into the category of instructional technology.

The other group advancing the cause of computer preparation for teachers was the Committee on Computer Education of the Conference Board of the Mathematical Sciences. Operating as a fact-finding team since 1969, this committee employed "systems-approach" thinking in their analysis and recommendations about the training of high school teachers. First they located the "real" problem—the education of faculty members in the colleges of education. Because these professors were neither skilled in using the computer as a research tool nor cognizant of its applications in the teaching-learning process, they were unable to teach computer courses to prospective and practicing high school teachers. The result was that by 1972 most teacher training institutions offered no programs in the discipline of "computers and education." Given this situation, these teachers were not ready to use computer-based instructional alternatives in their classes.

Because the committee recognized the value of computers in instruction, they recommended that the National Science Foundation sponsor programs to train high school teachers in the use of computers in their respective disciplines. Books and journals published in 1975 still address teacher training as *the* way to insure the effective use of the computer in the classroom. The message of concerned educators can be summarized as follows. Because teachers, for the most part, teach as they have been taught, they have been and will continue to be reluctant to utilize new, alternative teaching methods afforded through the computer. On the other hand, if teachers can be exposed to several practical collegiate courses in which they work with computers and actually see what power these machines have in relation to instruction, then the teachers will use computers in situations where such technological devices can enhance learning. In short, to apply the methods of computer-assisted instruction (CAI), teachers must be taught instructional applications of computers.

COMPUTER EDUCATION FOR TEACHERS

Computer education for teachers is necessary to improve the quality of the teaching profession. Teachers must know multiple approaches for the teaching-learning process. Teachers must be skilled in maximizing the learning potentials of their students and capable of selecting the most appropriate alternatives. Moreover, teachers must prepare youngsters not only to succeed academically in school but also to integrate wholesomely in our society. For these purposes the computer is well suited. Computer systems make learning alternatives available to classroom teachers. In addition, computers acclimate youngsters to our technological world. Without computer training, teachers are shortchanged in their preparation for the profession; they are handicapped in their classrooms. Computer education for teachers has become indispensable in professional training.

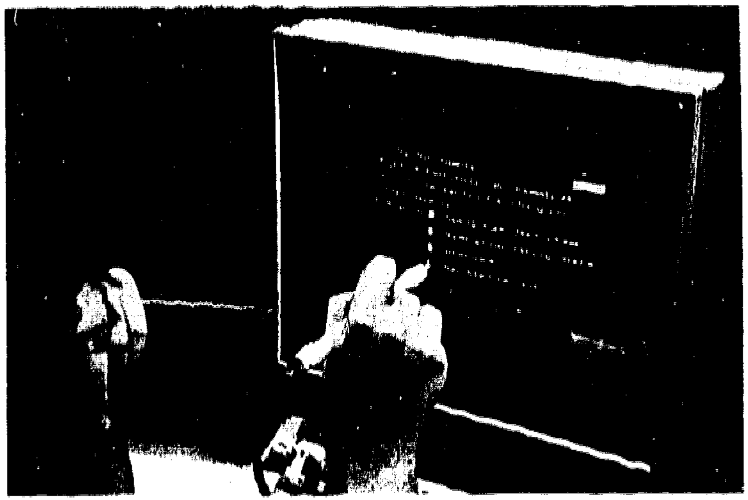
What is a Computer?

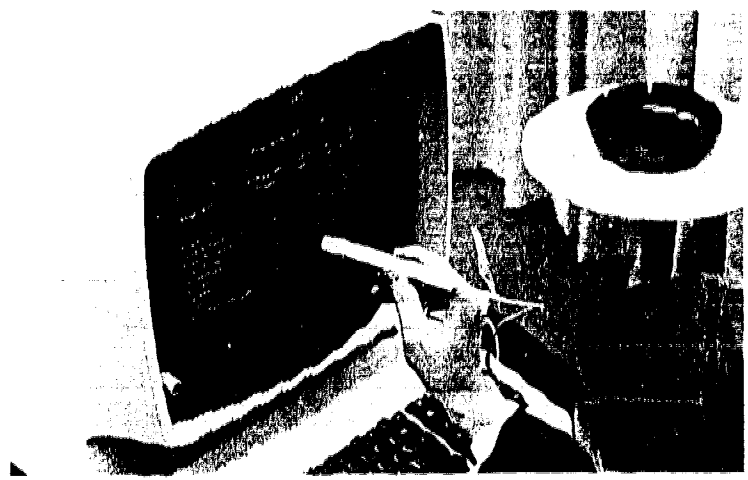
Computers are electronic devices capable of processing information at speeds approaching that of light. A computer consists of five basic components: input, central processing unit containing the arithmetic/logic circuits, memory or storage, control, and output. How these units are arranged physically depends on the particular computer system. Any attempt to define a computer with more precision or to describe the machine in painstaking technological detail would be fruitless, for today computer technology is rapidly changing. Computer experts in universities and industries cannot reach consensus on machine descriptions and generations. What is agreed upon, however, is that recent advances in monolithic systems technology have made computers smaller and faster. The industry has developed microscopic logic circuits housed in pocket calculators and computerized video games.

The value of the computer lies in the *intellectual* services it can perform. This could very well be why some people, including some educators, fear the computer—they feel threatened by a machine that renders intellectual services.

Aside from the modern pleasant-looking cabinets, which contain the interconnected units of a computer system, the real beauty of the machine is its ability to communicate with people. Our basic elements of communication are alphabetic symbols, which properly joined make up words. Then words joined according to rules of syntax make up sentences, which can be combined to convey complex thoughts. The basic elements of the computer, however, are the binary symbols 0 and 1, also called binary digits or "bits." How the computer knows 0s and 1s depends upon the computer's architecture, which is the electronic structure of the system. In general, magnetism induced by electricity determines the selection. Bits, in turn, are combined in groups to form words, which are "units" in data processing. A word could specify a quantity, an instruction, or a name. Words, represented electronically in groups to the machine, then link the human user and the computer.

The actual means of communication is known as a program. Generally a program is written in a higher-level language, such as FORTRAN, PL/1, BASIC, or APL, all of which include statements resembling English sentences and arithmetic expressions. Once the input (source) program, composed of a sequence of statements (instructions, mathematical equations, numeric data) which form an algorithm, is submitted to the computer, the control unit immediately operates an internally stored program called the compiler. The compiler's job is to translate the source program into the machine-language program developed in terms of bits and words which the computer understands. Then, assuming the programmer is accurate in syntax and algorithmic presentation, the computer processes the information according to the directions given in the program. In processing information the computer relies on the central processing unit, which is the





COMPUTER AIDS THE DECISION MAKER. This executive is using an electronic (light) pen to call for a detailed breakdown of a desired item in the summary report shown on the screen of the computer terminal. The computer will immediately display his requested frame and the communication can continue according to the executive's specifications. Photo courtesy IBM.

fastest component in the system. This arithmetic/logic unit contains counting circuits and AND, OR, NOT gates. With these electronic components the machine can calculate, sort information, compare data, make decisions, and perform all kinds of intellectual activities.

In a school system, for example, a student in a mathematics class could prepare a program for finding the roots of a quadratic equation. Assume the student has access to a math laboratory which houses a minicomputer system including several input/output typewriter terminals. The student could go to the math lab and type a program at the keyboard of one of the input/output terminals. Once the communication between the student and the central processing unit is initiated, the computer will process information in the program in its own way and in its own binary language. The machine-language answer is translated, under the direction of the control unit, to the language of the user. Then the power of the computer is finally shown in full glory when the typewriter types back the correct answer for the equation.

Up to this time, though, a smooth-operating system supplying accurate results has been assumed. If a program containing even one error in syntax is submitted to a computer, the machine generally will not process it. Instead the computer will respond by alerting the user to the error by means of a message. It is then necessary to "debug" the program. On the other hand, if a program contains a mistake within the algorithm or incorrect data, the computer generally will respond with an incorrect answer—which appears correct to the unsuspecting programmer.

From the preceding simplified excursion through the computer world, it should be evident that the computer is endowed with strengths, but it also has its weaknesses. These weaknesses can be diminished through clever programming techniques; the strengths can be augmented through ingenious technological improvements. For humanity, in general, the question is: How can the computer help me? For teachers, in particular, the question is: How can the computer help me teach more effectively?

Computer-Based Learning Alternatives in Schools

Computer-based learning materials for usage in computer systems, or CBLM, include textbooks, laboratory manuals, data bases, canned programs, animated films, computer-managed instruction program systems and packages, computer-assisted instruction program packages, and simulation and game program packages. They appear in various physical forms, such as paper tapes wound on reels, magnetic tapes mounted on reels or in cassettes, card decks, movie film, and workbooks. With computer systems, CBLM add a dynamic environment to the classroom. A rich source of information about computer-based learning materials and their role in instructional applications of computers is *Learning Alternatives in U.S. Education: Where Student and Computer Meet* written by a team of researchers directed by Robert Seidel. This Human Resources Research Organization group conferred the slogan CBLM on the materials.

Teachers prepared to use the computer for instructional purposes will find the machine resourceful in a variety of ways. Consider the following anecdotes.

Computer City Elementary School houses a minicomputer system with twenty television-screen typewriter terminals. These student stations serve as input/output units in the network. Faculty members can gain access to the computer laboratory at prescribed time periods during each week and use the computer facilities to provide drill, practice, or tutorial lessons in mathematics and language arts for their students.

During the year each teacher decides which youngsters could use the computer facilities and for what reasons. For example, Miss Jones may find several students behind schedule in subtraction skills. While a teacher aide supervises the other students, Miss Jones accompanies this small group to the computer room and teaches them how to use the typewriters to communicate with the computer. Once each child is identified to the machine by name and special number and the stored program on subtraction facts is called by its identification code, the rest is simple. The computer first greets the pupil by name and then begins the lesson. The pupil has to read the lesson from the screen and react through the keyboard to the computer's instructions. In this way there is a constant dialog between computer and pupil. Moreover, each pupil may work at an individual pace under the guidance of Miss Jones.

While the monitoring at the beginning is essential, later Miss Jones has the option of sending computer-literate youngsters to the computer room by themselves. A teacher aide, however, will be present to maintain order in the laboratory and to proctor these youngsters when necessary. Miss Jones could return to the computer room during her free time or after school to monitor the progress of her pupils by recalling their lesson and test responses which were recorded and stored in the computer's memory unit. Based on their performances on lessons and tests, Miss Jones will make her decisions about pupil placement. That is, she will decide whether a child should continue using different CBLM packages or work in the conventional situation.

Computer City's answer to individualized education is provided through computer-assisted instruction programs. Youngsters lacking basic skills can work with the computer in a drill-and-practice mode at various times throughout the school year to fortify their arithmetic and language arts skills. Youngsters ahead of their classmates can also use the computer for tutorial lessons, which give them a chance to work on more advanced topics.

While the Computer City Elementary School provides on-line, interactive computer services to its teachers and youngsters, the Modern Middle School provides off-line, batch processing computer services to teachers and pupils. This school rents two pieces of computer equipment—a mark-sense card reader for input and a typewriter terminal for output. These devices are connected by telephone lines to a large computer at a university in a neighboring state. The computer system at Modern provides a technological application called computer-managed instruction. Several teachers are conducting individualized instruction programs in mathematics and science. The input/output units are teacher aides to these faculty members.

Mr. Smith, an eighth-grade science teacher, conducts five general science classes each day. He has provided individualized instruction for three classes and conventional instruction—lecture, discussion, and laboratory work—for two classes. Mr. Smith, however, has a valuable aide to help him teach and supervise pupils in the individualized learning classes. A computer is a record keeper, test scorer, progress evaluator, and educational consultant.

Actually Mr. Smith's students do not work directly with the computer. The children have their own daily lessons centered on textbooks, audiovisual aids, and laboratory equipment. At the end of a lesson, each pupil answers several multiple-choice questions by marking in pencil certain designated areas on mark-sense cards. Mr. Smith collects these cards and presents them to the computer in batches through the card reader. A stored program in the distant computer initiates the electronic scoring and evaluative procedures. After completing a scientific analysis based on programming routines, the computer returns a diagnostic and prescriptive report for every youngster in Mr. Smith's classes. Mr. Smith retrieves these computer print-out sheets daily and conducts his classes according to specifications from the computer.

It should be noted that Mr. Smith has the freedom to work with individual pupils, a group of pupils, or the entire class whenever he chooses. He is not necessarily a slave to the computer. The beauty of computer-managed instruction lies in the supportive services provided by the computer. The teacher, even within this seemingly structured system, has ample opportunities for creativity.

Technologyville High School provides a rich variety of computer applications in both batch and interactive modes for its students. The school principal has purchased a card reader, a printer, and several keypunch machines, video screen/typewriter terminals, and hard copy/typewriter terminals, all of which are connected to a computer in the district administration building.

Students in Mr. Spock's advanced math class have been taught the WATFIV language, which is a version of FORTRAN (FORmula TRANslator). These students write sophisticated procedures for solving complex math problems. Then they keypunch the steps of their algorithms onto cards and submit these cards to the computer by way of the card reader. The computer does the "busy work" in making lengthy routine calculations and returns its answers. Often students have to revise their programs until the computer types back sensible answers as determined ultimately by Mr. Spock.

While most of the computer work is done in problem solving, occasionally exciting simulation exercises are conducted with the computer. For example, Mr. Spock's students prepared subroutines which were used with canned programs (card decks containing skillfully prepared algorithms to solve differential equations) for sending rockets to the moon and back to earth again. Plotting equipment, attached to the computer and therefore under computer control, was used to graphically display on print-out sheets the rocket's space journey. Each student persevered with the equations until they meshed correctly with the canned program; each student had the joy of seeing a rocket fly to the moon and back. There were no crash landings and no rockets lost in space either!

Other teachers at Technologyville use the computer for problem solving and simulation exercises in their classes. Every beginning student must take a fundamental computer-literacy course to learn how to communicate with the machine in BASIC (Beginner's All-Purpose Symbolic Instruction Code). All are prepared to use programming skills when necessary through high school. Teachers, also familiar with BASIC, take advantage of their computer-literate students and integrate computer-based learning activities in their courses for enrichment.

To this end the school provides a number of Huntington Two simulation packages, which are popular in biology, physics, and social sciences. There are modules in genetics, water pollution, nuclear reaction, and presidential elections, to name a few. Huntington Two programs are written in BASIC, considered by many educators to be the easiest language to learn. Under teacher supervision, each student works with simulation materials by supplying instructions and data to the commercially prepared programs. The student, moreover, does not have to be an expert in BASIC to interact successfully with these simulation programs.

For the sake of illustration, assume students in a tenth-grade biology class are working with a Huntington Two program called POLUT which simulates pollution of a river, lake, or pond with various types of waste matter. It is the task of each student to enter data on prescribed treatments for purifying the water and rendering it innocuous to fish. To complete this task, the student chooses specific numbers from the numerical domains assigned to the program variables, which include kind of water, its temperature, kind of waste, dumping rate, and type of treatment. Once the data in each of several treatment sets are selected and entered into the prepared program, the computer returns its disposition to the program by typing out data and graphic displays on several sheets of fan-folded computer paper (hard copy). The result of this dynamic learning encounter is that each student is afforded not only a chance to study strategies in pollution control but also an opportunity to participate in a vicarious experience.

The Huntington Two packages, however, presented a system implementation problem. The programs were prepared for paper tape readers. Technologyville High School did not have these machines. The administration solved the problem by hiring computer systems experts to convert Huntington programs from paper tapes to magnetic media for adaptation to the school computer system. These highly trained technology experts have also been available to help teachers code their computer-assisted instruction programs into computer-based learning materials for smooth operation with the existing computer system.

Technologyville even offers guidance counseling through computer programs. And the chess club is experimenting with computer chess programs which are games for extracurricular activities. For guidance counseling and gaming applications, a student can converse with the computer by touching the screen with a light pen, an additional input device. With the guidance programs, the student points to answers shown in multiple choice lists, for example, in deciding upon a career or a college. With the chess programs, the interaction is much more vibrant. The screen shows a chess board with the pieces in their initial positions. The student who wishes to play against the computer uses the light pen to touch each piece in its square and in the square it is to move to. The computer displays its countermove; and the game goes on to checkmate or stalemate. While computer chess matches are exciting for the members of the chess club, this particular chess program designed and implemented by Dr. King and Mr. Knight, the faculty sponsors, has given a decisive advantage to the computer in many a match.

Although the foregoing illustrations are fictitious, the computer applications portrayed are typical, with the exception of the chess program, of situations occurring today in the K-12 schools in America. The list of computer activities, in fact, is far from complete. On the more technical side, some vocational-technical high schools have computer science programs where courses are offered in the operation and repair of computers. Other possibilities such as systems maintenance are available. Therefore, under the rubric of computer-based learning alternatives comes a wide assortment of elementary and secondary school applications.

Computer Technology in Society

Today, virtually no one's life is not affected either directly or indirectly by the computer. This "thinking machine" that stores data en masse, manages real-time systems, instructs, plays games, makes crucial decisions, and attends to a host of other intelligent activities, has made its way into the home and the school, and into political, industrial, commercial, and scientific enterprises. The revolution generated by the computer has the experts wondering what new applications will be thought of next.

On-the-horizon applications include television-typewriter computer terminals in the home. Telephone terminal connections to computers, which will deliver messages to people in their homes, will be possible when voice answerback systems are perfected. Of special interest, too, is the field of artificial intelligence, a discipline primarily concerned with the ability of computers to perform intelligent tasks. Researchers have already equipped computers with "arms," "eyes," and "ears," making them the forerunners of Isaac Asimov's robots of tomorrow.

On the current front appear a plethora of impressive performances by computers—all to the benefit of society. The pictures show how computer systems aid consumers, scientists, and business people. Computers also provide employment, for people are needed to operate, monitor, and service these machines.

A real-time system is a computer that takes in information, processes it, and produces data and decisions rapidly enough to influence the processes being controlled or monitored. Typically real-time systems involve processes rather than humans at the consoles of computers. For example, a real-time system can be used by chemists in a laboratory to control an experiment. Various devices such as sensors or transducers, under computer control, can be coupled to laboratory apparatus and thereby complete the input, processing, and output cycle. The result is that the computer directly aids in the control of the experiment. The chemist, however, has the opportunity to interact with this system through a conversational terminal connected to the computer.

Real-time systems service the public in many ways. Examples include airline reservation systems, hospital patient monitoring, automobile traffic control, commercial inventory control, and industrial process control.

Technological advances have now placed the computer in the home. The microcomputer (smaller than the mini) is the "resident computer" housed in a device which can be connected to the home television set. With this arrangement, the family can enjoy playing games such as tennis, soccer, basketball, football, and handball on the screen. As the electronic game business grows, more games at reduced prices will be offered to the public. The door to all sorts of recreational possibilities has been opened through the computer.

Volumes could be filled on ways in which computers perform for people. This fact, in itself, is a good reason for concerned individuals to pursue the study of computers, especially of how they can be of personal service. For further reading along this line, *The Emerging Technology* and *The Scientific Process and the Computer* are invaluable.

WHAT TEACHER TRAINING INSTITUTIONS ARE DOING ABOUT COMPUTER EDUCATION

This section is the result of a small-scale research project designed by the author to ascertain the kind of computer courses currently offered to prospective and practicing teachers within American colleges and universities. Two hundred-fifty institutions of higher education ranging from large, well-known universities offering the doctorate to small colleges offering only the baccalaureate degree were selected. An explanatory letter, a four-page questionnaire, and a self-addressed stamped envelope were sent to 250 college administrators in the fall of 1975. By January, 1976, responses had been collected from 175.

Results of a Recent Nationwide Survey

The questionnaire was designed to examine the kind of computer courses currently offered to teachers and teacher candidates and to elicit opinions from educators on five computer-related topics. The first part of the instrument included mandatory objective questions; the second, optional subjective topics.

The objecti'e part of the questionnaire was an overview not precise enough to delve into all details of computer courses offered at each institution. Certain patterns emerged, portraying the impact of the computer on teacher education.

To grasp the full significance of the conclusions, the reader should keep in mind the following facts. First, several institutions were selected in each state. Second, while the author did not know the extent of the computing facilities at each institution selected, large prestigious universities were deliberately chosen. In other words, the sample was not completely random. Inclusion of the great universities did not bias the sample in favor of impressive computer programs for all teachers because there is a cancelling effect among these universities. That is, some prestigious schools do offer comprehensive computer programs, while other "name" schools do not offer them. Third, the survey concerned computers only and not hand calculators.

Figure 1 presents the data concerning course offerings. Because 126 of the participating institutions had colleges or schools of education while only forty-nine had departments of education, the word "college" will be applied as an umbrella term.

The following statements are assumed:

1. It is normal in most colleges of education for upper-level undergraduates to take lower-level graduate courses and vice versa.

2. It is normal for students in a college of education to enroll in courses outside the college, but within the same institution, for which they have the proper academic prerequisites.

3. A comprehensive program consists of at least three courses, among which might be: a survey course leading to computer literacy; introduction to computer programming; computer-assisted instruction for teaching purposes; and computer-assisted instruction for learning purposes (such as PLATO, a tutorial system). The word *comprehensive* implies appeal to a general audience such as elementary and secondary education majors in any subject field.

4. Special audiences refer to mathematics education, natural science education, business education, or vocational/technical education majors, to educational administrators, or to doctoral students engaged in research.

5. General courses denote introductory courses such as computer literacy or easy BASIC programming.

Examined in another way, category A is associated with colleges of education which have recognized the need for at least three computer courses designed for teachers and aspiring teachers. Now elementary education, social science, and language arts majors all have a chance to participate in computer-related courses along with math, science, and business education students. In the opinion of some educators, a sequence of three com-

Computer-Related Courses Offered by Teacher Training Institutions in the 1975-76 Academic Year

Key to the Categories*

A: College of Education offers a comprehensive program. Additional courses for special audiences may be taken inside or outside the College.

B: College of Education offers one or two courses similar to those within a comprehensive program. Additional courses for special audiences may be taken inside or outside the College.

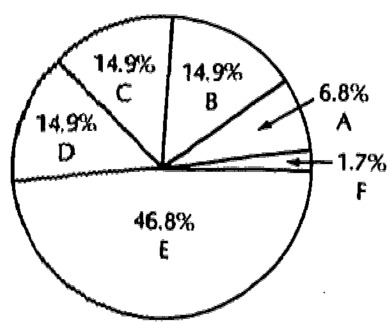
C: College of Education offers at least one course to a special audience. Additional courses for special audiences are available outside the College.

D: College of Education offers no courses to teachers, but another division of the institution such as computer science offers at least one suitable general course. Additional courses for special audiences are available.

E: College of Education offers no courses to teachers. Courses applicable to special audiences are available outside the College.

F: College of Education offers no courses to teachers. Courses applicable to special audiences are not available anywhere in the institution.

Figure 1



*The delineations for the categories were set according to the stated constraints before assigning institutions to divisions. The same number of institutions fell in three different categories.

puter courses constitutes the minimum for teachers to feel comfortable using the computer in their classrooms. The teacher has to feel master of the machine before feeling the master of the classroom in which the machine contributes to the instruction. In summary, then, universities belonging to A could be considered "computer conscious," providing diverse options in the selection of computer courses.

Staff at colleges of education in category B have established a course or two with such titles as "Computer Programming and Applications for Educators," "Instructional Uses of Computers," "Computer Applications in Education," and "Characteristics of Computer-Based Instruction." As the names suggest, these courses would have wide appeal for teachers.

Most colleges of education in group C have recognized the need for computer education for teachers in statistically oriented disciplines. Rather than encourage students of education to take computer courses in other institutional divisions, they have designed such courses as: "Educational Data Processing," "Curriculum Development in EDP for Teachers of Business Data Processing," "Numerical Methods for Teachers," and "Computer Applications in Higher Education Administration." Some colleges of education also feature computer courses for mathematics teachers, special education teachers, educational researchers, and school administrators. The thread of commonality in all these courses is their direction not to all teachers but to specific groups of teachers.

The group D colleges are interesting because these schools show no evidence of computer courses for teachers. Yet another department in each institution offers at least one general course in which any student may enroll. On these campuses there appears to be some agreement between the college of education and another division such as computer science or mathematics. For example, if the computer science department already has at least one suitable introductory course in appreciating computers, the college of education does not need to duplicate that course.

A case in point is Brooklyn College of the CUNY system. While the School of Education offers no courses in computer education, the department of computer and information science has a course which, according to the department chairman, is appropriate for teachers. This introductory three-credit course, called

"Computers in Our Society," includes such topics as the current and future role of computers in society, introduction to data processing, the information revolution, basic concepts in computer technology, and learning and using a programming language.

Other institutions in category D offer similar courses. The value of these introductory courses for teachers is that they promote computer literacy. This awareness is a worthwhile beginning for today's teachers living in a technological society, whether or not computer facilities are available in the schools.

The colleges of education in category E comprise almost half of the sample. These colleges are part of institutions which provide computer courses in divisions such as business, computer science, engineering, mathematics, and natural science. While many are suitable for business, mathematics, and science teachers, the content or subject matter of these courses is too advanced for students of elementary education, language arts, or social science education. This is not to say that the latter group of students are inferior, but only that computer courses conducted outside the College of Education are typically directed toward special audiences or user groups. Thus, the College of Engineering directs courses to engineers; the department of mathematics tailors its courses for mathematicians, and so forth.

The three colleges of education in group F constitute about 2 percent of the sample. One institution had no computer facilities. The other two gave evidence of using the computer for administrative applications only.

To summarize the implications of the graph in Figure 1, a majority of American colleges of education do not offer "tailor-made" computer courses. Only 36.6 percent offer computer courses, while 63.4 percent offer none. If the 14.9 percent from category D, those that provide at least one suitable general computer course outside the college of education, is added to the 36.6 percent, then the total of 51.5 percent suggests that about half the institutions of higher education in America are providing ample opportunities for computer education.

Unfortunately, in practice the situation is not so clear-cut. In most colleges these students have a choice about taking computer courses. Some professors remarked that students of education typically do not elect computer courses. At the same time, other professors indicated that computer courses, especially in the college of education, were popular. And a few professors reported that where the college of education does offer computer courses, students enrolled in other divisions of the institution have enrolled in these courses.

A more qualitative look at the computer education of teachers will be provided in the next section. Nonetheless, a final note should be mentioned here. While the computer was available for instructional purposes before 1960, especially in the larger, well-known institutions, by the late sixties a vast majority of students in higher education had access to the computer both as a tool in instruction and as an object of instruction. In the seventies, however, an increasing awareness of the instructional value of the computer has pervaded the colleges of education. Although progress is far from rapid, there is an encouraging trend. Each year additional computer courses for educators are offered. It is the students—teachers and future teachers—who must make the final decision to remain indifferent or get involved with the computer through these courses.

Professional Opinions on Teacher Training

In an optional section of the questionnaire respondents were encouraged to respond to any or all of five statements or to write personal opinions on computer education for teachers. Sixty-three of the 175 respondents chose to answer at least one topic, replies ranging from one-word answers to a seven-page essay.

The five statements were:

1) There is too little in the way of preparation courses for teachers.
2) Budgetary problems are obstructing the implementation of computer courses.
3) Many American colleges of education are not providing any computer courses for teachers and are forcing students of education to take courses in other divisions of the university.
4) Teachers without computer backgrounds who are asked to teach computer courses should get their training from inservice programs provided by their employing school districts.

5) Computer courses are not necessary in the school curriculum (K-12); therefore, teachers in general need not be concerned with taking computer courses.

Given the generality of the first statement, the respondents supplied multiple answers. Some educators agreed with the statement, for the most part alluding to the lack of computer courses in the curricula of many American colleges of education. Others said the existing situation was as it should be. Some narrowed the statement by referring to teachers according to their subject matter or grade, saying computer courses were necessary for teachers in fields related to mathematics. Others believed computer courses should be incorporated in general in master's programs. Respondents who believe the computer should be part of the total curriculum agreed with the statement; those who believe the computer should be included in only part of the curriculum, such as in mathematics-related subjects, did not agree with it.

Statement 2 on budgetary problems seemed to present difficulty, for many respondents are not intimately involved with budgeting in their institutions and many ignored the topic completely. Some agreed that institutional budgetary problems meant computer courses were omitted from the curriculum. Others cited more penetrating reasons for paucity of computer courses. Among the reasons were the faculty's lack of expertise in instructional use of the computer, educators' fear of the unknown, administrators' ignorance about the instructional worth of the computer, and the faculty's failure to attain promotion in the university. This last factor stems from the general assumption that faculty members who spend great amounts of time experimenting with the computer, developing materials for computer use, and implementing computer courses usually lose valuable time from more scholarly research or in publishing and thereby fail to move up in professorial rank.

The third statement could be considered a variation on the first. The majority opinion affirmed that many American colleges of education were not providing any computer courses for teachers, thereby forcing their concerned students to take technological courses in other divisions of the university. Educators with this idea are thinking about computer education for *all* teachers. The main ingredient in their conceptualization is that computer courses outside the college of education typically require scholastic prerequisites not usually possessed by education students, with the exception of those in the mathematical sciences. This being true, nonmathematically minded students generally find these rigorous technologically oriented computer courses too difficult and irrelevant to their needs as teachers. Hence, the focus of the majority opinion hinged on the depth and subsequent applicability of these computer courses to the typical student in the College of Education. The minority opinion, on the other hand, considered computer courses outside the College of Education suitable for the special groups of teachers or future teachers who elect these subjects. In effect, they said the colleges of education did not need to duplicate offerings.

Opinions of statement 4 typically were that universities, colleges, and trade schools should provide the necessary inservice computer training for teachers who are requested by administrators to instruct their classes using the computer. Respondents generally agreed that the school districts should cover the costs of inservice programs.

The overwhelming rejection of statement 5 indicates that educators are well aware that the computer is an instructional innovation which is here to stay. In fact, each year more schools utilize the computer for instructional applications, and these are increasing in variety.

J. Myron Atkin, dean of the College of Education at the University of Illinois at Urbana, expressed his view of the entire situation:

> Generally there is very little or nothing about instructional applications of computers (IAC) in the training of teachers. All teachers in training should get experience with the applications of computers. Some of the teachers should specialize in IAC and take a minor in this area.
>
> Inservice courses for teachers, to enhance their understanding and knowledge of IAC at various levels, should ideally be available both in the school districts and at universities. Computer science courses in school curricula are generally much less useful than integrated instructional applications of computers across the whole school, and this implies integrated cooperation with the decentralized administrative applications.

John J. Hirschbuhl, director of the Computer-Assisted Instruction Center at the University of Akron, commented on statement 5:

I do not accept the assumption that school children do not need computer courses. My belief is that the young need to spend as much time as possible exploring the uses of the computer. This exploration should begin when the student enters the schoolhouse door and should continue after he leaves it. This cannot take place unless elementary and secondary teachers are trained in the instructional application of the computer. They need some knowledge in each of the following areas: 1. hardware; 2. software; 3. courseware; 4. peopleware. In addition, educators must learn how to integrate the above four wares with one another and how to implement them to their own course study. Admittedly, this is a heavy demand when one considers the training that practicing teachers now have. In order to begin correcting this deficiency, teacher training institutions must begin to provide and require at least twelve hours of training on the uses of computers in education.

The Associate Dean for Program Development in the College of Education at Ohio State University, Kevin Ryan, offered a penetrating response concerning computer education for teachers:

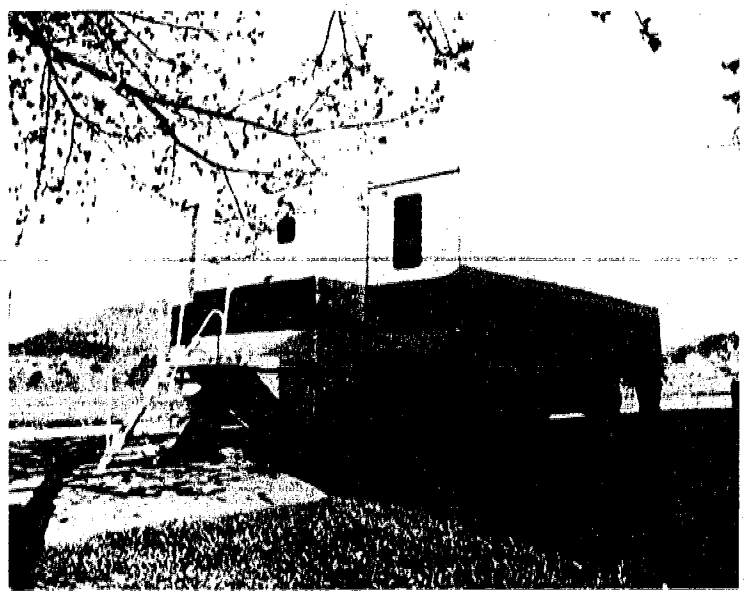
> This is part of a large problem in teacher education, which is that we have too many important tasks to fulfill and too few resources (i.e., time, money, student-teacher ratio).

Stuart E. Whitcomb, associate dean for academic affairs and a professor of physics at Earlham College in Indiana, said:

> After using an IBM 1130 computer since 1968 Earlham College has, in 1975, purchased a DEC 11/70 system. The principal reason for the change was the expanded capabilities of the new system to service a number of terminals and to permit computer-assisted instruction. One of our goals for the new system is that by graduation each Earlham student will have had some experience with the computer. This experience may be as little as the use of a computer-assisted self-study module or it may be as much as the design and execution of programs. We hope that, in most cases, this experience will include some familiarity with the use of a computer for data processing and with information storage and retrieval.
>
> Since these are the Earlham College goals for all students, they are also the goals for those Earlham students who are planning on teaching careers. Generally, the desired computer experience will result from the introduction of the computer into a variety of subject matter courses rather than from taking specific courses in computer usage. Obviously the extent to which this occurs depends upon the motivation toward this change on the part of the Earlham faculty.

At present, most prospective teachers at Earlham have little contact with the computer and for most of them teaching a course

Shows teachers (students) actively involved in the CARE project. Photo courtesy of The Pennsylvania State University.



A NOVEL MOBILE APPROACH TO INDIVIDUALIZED INSTRUCTION FOR TEACHERS. The Pennsylvania State University mobile van for delivering the CARE (Computer-Assisted Remedial Education) System to teachers in rural areas. The inside of the van contains sixteen student stations and a central control unit. Photo courtesy The Pennsylvania State University.

in computers would be difficult if not impossible. It is hoped that this situation will change.

Patrick C. Fischer, head of the computer science department of the College of Science at Pennsylvania State University, offered comments typical of survey respondents:

> Students in the College of Education at Penn State tend to take Computer Science 402, which is intended to be presented in a less mathematical way than our introductory courses for scientists and engineers. Even so, there is some difficulty in presenting material which is inherently mathematical in nature to persons without a background in mathematics.
>
> Given more budgetary support, we could offer a "computer appreciation" course. This would give a general understanding of the nature of computers in our society but would not prepare a person to teach a FORTRAN course in a high school.

The problem underlying computer education for teachers is the kind of courses that should be added to the standard curriculum. These courses must simultaneously have economic feasibility for the institution, instructional applicability to the level of the learners, and relevance to the needs of these learners—the teachers and future teachers. The following universities have solved the problem, at least partially. They are the pioneer schools which serve as the exemplars for computer education programs.

Computer Education Programs in Universities

Teachers College at Columbia University in New York City, long a recognized leader among American colleges of education, has a program in "Computing and Education" which leads to the M.A. degree. Blessed with its own Burroughs B4700 computer in addition to the enormous computing facilities of Columbia University, Teachers College first offered computer courses in 1967. Today the "Computing and Education" program encompasses nine courses in three major divisions: 1) programming and man/computer communication; 2) administrative use of computing; and 3) instructional uses of computing. The main goal of the M.A. program is to produce graduates proficient in computing and capable of initiating and maintaining computer activities in their institutions. For the ambitious student this program can be completed in one year of full-time study. Any student is eligible to elect courses from the program because extensive mathematics is neither required for nor used in any of the courses.

Titles of courses in the M.A. program are: 1) Computing Literacy—An Introduction to Computing and Education; 2) Programming I: Concepts and Methods; 3) Programming Language Workshops; 4) Programming II: The Practice of Programming; 5) The Computer as an Instructional Aid; 6) Teaching Computer Programming in Schools and Colleges; 7) Analysis, Design, and Implementation of Administrative Data Processing Systems; 8) Survey of Administrative Data Processing Systems for Schools and Colleges; and 9) Interdisciplinary Colloquium in Computing and Education. The languages employed in the programming courses are FORTRAN, for mathematical problem solving; COBOL, for business problem solving; and BASIC, for general problem solving. The overall learning outcome of the M.A. program appears to be how to use the "four wares" cited earlier.

The College of Education at the University of Illinois in Urbana first offered computer courses in 1967. This college had an advantage because in 1960 the first large-scale computer-assisted instruction project was born there. PLATO, Programmed Logic for Automatic Teaching Operation, was invented and developed under the direction of Donald Bitzer at the Computer-Based Education Research Laboratory not far from the College of Education. A computer-based educational system for delivering CAI to schools and colleges nationwide, PLATO offers instruction from the collegiate level to the elementary school level in a hundred teaching areas. Therefore, students of education at Illinois have the advantage of learning their lessons by way of a computer-teacher, interacting with the PLATO materials on site, and taking courses about how to use the computer in instruction.

Among these computer courses open to students at Illinois are: 1) Introduction to Computers for Teachers; 2) Introduction to Computers for Secondary School Teachers of Mathematics; 3) Computer-Assisted Instruction; 4) The Computer and Mathematics Education; 5) Computers for the Whole School; and 6) Computer Uses in Education. These courses are given in the departments of computer science, secondary and continuing education, and educational psychology. The double value of these courses is that they provide essential preservice or inservice training in a dual capacity. The future teacher or teacher learns not only how to work with the computer but also how to make the computer work in the classroom. The CAI course, for example, covers the teacher's role in development, management, and criticism of CAI lessons. Instructional programming and the design of CAI lessons are part of every student's encounter with this 4-hour course.

Northwestern University boasts a unique computer project in its School of Education. Having produced the MULTITUTOR system, which is compatible with PLATO, this Computers and Teaching project is partially responsible for the tremendous use of the computer at Northwestern. Dr. Claude Mathis, director of the Center for the Teaching Professions, which houses the CAT project, says the School of Education administers up to $90,000 worth of computer time a year to provide computer-based instruction for both learning and teaching purposes. Jim Schuyler, former director of the project, was instrumental in helping establish computer literacy programs in colleges of education and received several requests a year from people wishing to start these courses.

Northwestern's CAI courses are:

1) *Languages and Systems*—provides a full description of PLATO IV and TICCIT systems, with partial coverage of Coursewriter, PILOT, PLANIT, and other CAI languages. Students learn to write simple programs in TUTOR, the language for the PLATO system. (A PLATO terminal is connected from Northwestern to the University of Illinois at Urbana.)

2) *Courseware Design Seminar*—Students learn about educational design and produce and test 30-minute CAI segments.

3) *Individual Tutorials*—Students produce courseware and test it in actual "battlefield" conditions.

In addition to these computer-aided instruction courses, the School of Education at Northwestern offers computer-related courses in educational research methods.

The Catholic University of America offers an impressive set of computer courses in the Center for Educational Technology at the School of Education. As both inservice training for teachers in the Washington metropolitan area and preservice training for M.A. and Ed.D. students in the department of educational technology, these courses are specifically directed toward helping teachers use these machines effectively in classroom instruction.

The courses focus on modes of instruction utilizing computers which include computer-assisted instruction, computer-based problem solving, computer-managed instruction, and computer-assisted testing. This contrasts with instruction about computers typically included in computer science courses. Included in the set are 1) Introduction to Computers in Society; 2) Applications of Computers in Learning; 3) Instructional Uses of Computers I; 4) Instructional Uses of Computers II; and 5) Advanced Seminars in Instructional Computing. Even more computer-based educational experiences are provided through practicums, seminars, and workshops.

The programs on these four campuses equip the teacher with strategies necessary to effectively teach students with the computer in the CAI mode. The Pennsylvania State University system, CARE (Computer Assisted Renewal Education), has lessons delivered in the CAI mode to train teachers of the handicapped, the disabled, and the disadvantaged.

The unique element in the CARE program is the mobile van that takes CAI to rural and urban sites throughout Pennsylvania and neighboring states. It converts to an eighteen-feet wide classroom complete with sixteen student stations. Penn State University project staff believe this van represents the first new delivery system for continuing education programs since broadcast television.

CARE comprises four courses. These are: CARE 1: Early Identification of Handicapped Children; CARE 2 and 3: Diagnostic Prescriptive Teaching of Preschool and Primary Children; and CARE 4: Education of Visually Handicapped Children. These courses are primarily geared to the needs of special education teachers for preschool and elementary school youngsters; yet secondary teachers, school administrators, psychologists, and other school-related personnel have also found these courses relevant to their needs.

The educative appeal of the CARE program is that three credit, collegiate level courses are brought into the educators' neighborhoods. Busy teachers can go into the van and use the computer equipment to continue their coursework any day or evening throughout each week. The one constraint, however, is that the teachers must complete their lessons within the seven-week period that the van is parked at a particular location.

COMPUTER EDUCATION TRENDS IN AMERICAN SCHOOL DISTRICTS

A 1970 book titled *The Computer in Secondary Schools: A Survey of Its Instructional and Administrative Usage*, cited among other important facts that mathematics teachers usually initiated the instructional application of computers in schools. Considering the typical university curriculum in the 1960s, it is no wonder that the math teachers were the avant-garde faculty members in American secondary schools. Teachers in the math field who had learned how to think problems through algorithmically, that is, in a logical sequence of steps, found communicating with the computer relatively easy, typically through FORTRAN programs. These people for the most part were at home in colleges of engineering, business, and liberal arts where computer courses first appeared in the curriculum.

Enthusiastically, secondary mathematics teachers introduced the computer for problem solving to their students. Where the introduction was well executed, students readily adapted their learning styles to the gadgetry of the computer. Faculty members in departments other than mathematics, however, were usually not quite so pliable as the students. Many resisted using the computer at all. Despite the resistance, progress continued largely as the result of the missionary work of dedicated individuals and such organizations as the National Council of Teachers of Mathematics, Mathematical Association of America, Association for Computing Machinery, American Federation of Information Processing Societies, EDUCOM—Interuniversity Communications Council, Inc., Association for Educational Data Systems, and the Association for the Development of Computer-Based Instructional Systems.

A 1975 study by the American Institutes for Research found that school systems are using the computer more fully for administrative and instructional applications. More schools gain access to computers each year while fewer schools are ending computer uses. In secondary education the most predominant applications are: 1) using the computer as a problem-solving tool; and 2) offering computer science courses, where computer science relates to programming and systems design and operation. While the computer is still used most often in mathematics instruction, a diversity of other instructional applications have also been recorded. It can be projected that within the next decade every secondary school in the country will have access to a computer system for some type of administrative or instructional application.

This same study uncovered a significant number of computer applications in courses for both junior high and elementary school youngsters. These lower-level applications are offered to promote compatibility with the educational programs in the high schools.

A number of current studies support the conclusions that 1) schools are using and will continue to use computers for instructional purposes; and 2) school administrators recognize the need for teacher training about computers. Coupled with these findings, the author's study shows that college administrators and professors also concur—the time for teacher training is now.

Three Models for Change

Now that the computer appears to be in the school to stay, new roles for teachers are emerging. The era of chalk and talk alone is ending. This does not mean that the teacher will be replaced by the computer. On the contrary, the teacher will always have a place in the classroom, be it open or closed. Most educators would agree with Harry S. Broudy, emeritus professor of the University of Illinois, who says that a mystique in teaching involves a mysterious change that takes place between the teacher and the learner during the teaching-learning process. The change might be from ignorance to knowledge or from folly to wisdom; but whatever this mysterious change is, a machine does not have the power that people have to partake of it. Because the mystique will always be present in the classroom, the teacher will always hold a place as supervisor of instruction. It is in that supervision that the teacher will exercise choice of learning strategies and alternatives to use to maximize the learning potential of each youngster in the class. Here is where the computer enters.

One suggestion is that a new department of computer science could be created in the senior high school. These teachers would be responsible for teaching courses about the computer; problem solving through programming; systems design, operation, and maintenance; and supervision of other computer-based learning experiences. It is also possible that these computer science educators would be available to other faculty members in schools throughout their districts for consultation and for coordinating instructional applications of computers.

Another possibility, which seems more promising in some ways, would be the requirement that all teachers take at least three computer-related courses either through preservice or inservice education to gain permanent certification.

A third model for change would be simply a combination of the two preceding ones. In this model teachers would have a basic background in general instructional uses of the computer and would also be skilled in uses especially suitable to their specialties. The cadre of teachers from the computer science department would be available to teach the more rigorous computer courses and to render consulting services to the computer-wise teachers.

In summary, the three models for change are: 1) a cadre of computer science teachers in secondary schools; 2) all elementary and secondary school teachers knowledgeable about computers and their applications; and 3) a team of computer scientists and computer-literate nonspecialists.

A final consideration is state departments of public instruction. A systematic check of the fifty states revealed that three states have incorporated computer science in their certifiable teaching areas. Twelve cited computer requirements within data processing courses for business or career education teachers.

The three states with computer science certification are Texas, Utah, and Wisconsin. The Texas State Board of Education has recently authorized a teaching field called Computer Information

System. The specific requirements for this teaching field are twenty-four semester hours, of which twelve must be advanced, consisting primarily of mathematics courses in computer information. Utah grants a composite teaching major in the area of Mathematics/Computer Science/Statistics. The composite major includes not less than sixty-two quarter hours of credit distributed among these three subjects. Wisconsin approves both a computer science major and minor. For the major at least thirty-four semester credits are necessary; for the minor at least twenty-two semester credits are required.

Taken collectively, the state attitude appears to be one of indifference. There seems to be little chance in the near future of any state requirements concerning computer education for all teachers. This does, in effect, place responsibility for initiating computer education for teachers where it belongs—in the teacher training institutions, especially the colleges of education.

Results of a National Survey of Superintendents

A school survey, featuring a research design similar to that used in the college survey, was conducted to check attitudes concerning the three models for change and the training of teachers using computers for instruction.

A survey of 125 superintendents in fifty states, which produced seventy-eight responses, showed that 52.6 percent of their districts use computers in some way for instruction; 39.7 percent do not use computers for instruction; and 7.7 percent are making plans to use computers on an instructional basis. It should be noted that programmable calculators, also called maxicalculators, were accepted as computers for this survey.

The forty-one school districts using computers in at least one of their schools and thirty-seven not currently using computers in any schools within the district were treated separately in tabulating attitudes concerning the models for change mentioned in the previous section. These attitudinal responses are shown in Figure 2.

Based on the preferences shown in Figure 2, a plausible conjecture is that personnel in school systems using computers know from experience that, given a choice of the three models, having a team of computer specialists work with computer-literate nonspecialists is the best method for facilitating tech-

Figure 2

Superintendents' Preferences Concerning the Three Models for Change

I. Schools Using Computers in Instruction	
1) a computer science department in secondary schools	17.1%
2) every teacher required to take three computer science courses	17.1%
3) a computer science department and every teacher trained in basic uses of the computer	51.2%
4) none preferred	14.6%
II. Schools Not Currently Using Computers in Instruction	
1) a computer science department in secondary schools	43.3%
2) every teacher required to take three computer science courses	10.8%
3) a computer science department and every teacher trained in basic uses of the computer	35.1%
4) none preferred	10.8%

nological instruction. On the other hand, personnel from nonuser school systems may believe that the computer is too complex for the average teacher to use efficiently in the classroom. Therefore, these educators think that computing activities within a school district are best left in the hands of computer science specialists.

On the qualitative side, the research shows that in user schools, computing ranges from problem solving in mathematics to multiple applications (i.e., CAI, CMI, problem solving, simulation, gaming, and computer science). In some districts only the math teacher uses the computer. In other districts as many as a hundred teachers use the computer in a variety of ways. The dominant trend is for a few mathematics teachers to use the computer exclusively. In fact, computer applications in mathematics far exceed those in other subject areas. Results, however, are encouraging, for some school districts are utilizing the computer in multiple departments throughout their schools.

The survey shows that most teachers who are currently using the computer received instruction through preservice or inservice university courses, including National Science Foundation summer institute courses. The poll also shows inservice training sessions conducted by the employing school districts to be a popular method for computer education. To a lesser extent, teachers have been trained through inservice sessions conducted by computer manufacturers or by experts at a regional consortium such as LOCAL or through individual instruction from another teacher. Project LOCAL, Inc., is a consortium near Boston for teaching teachers to use the computer in science, business math, social studies, and elementary classrooms. Sometimes teachers from the schools serviced by LOCAL help with the instruction.

Computer education for teachers demands a concerted effort by teachers, administrators, inservice consortia, colleges, computer vendors, educational organizations, and even the government. If these people are convinced that the computer is a valuable alternative for effective instruction, they will act together, as they have done in some localities, to make the new technology work for the benefit of all—especially the students.

CONCLUSION

Computers have been used for processing complex mathematical formulas and intricate statistical procedures to predict educational futures. What about the future of the computer in education? A noted futurist, Harold G. Shane, University Professor of Education at Indiana University in Bloomington, presents his thoughts:

> Since the middle sixties the computer has repeatedly and successfully demonstrated its usefulness in education. At least for the foreseeable future this trend seems certain to continue. Furthermore, the impact will continue to be felt from the early childhood years through the secondary school.
>
> At the same time it must be recognized that increasing costs, inflation, and public resistance to increased expenditures may flatten the growth curve of the computer in U.S. schools. In the analysis it must be recognized that schooling at all levels during 1975-76 will top $100 billion if state, local, and federal monies are added together. . . . With respect to secondary education the computer has long since become an integral part of higher education and also should enjoy increasing use by various educational agencies not on the conventional college campus.
>
> Insofar as teacher education is concerned, the use of the computer undoubtedly will be accelerated or slowed depending upon the outcome of the present debate regarding competency-based teacher education and the use of electronic equipment therein.

There is an enormous volume of literature about the computer, its instructional applications on all levels, its failures, and its successes. The Annotated Bibliography suggests extensive supplementary reading for those desiring to pursue either the computer on the educational scene or concepts related to those expressed in this fastback.

The question of whether *all* teachers or *some* select group of teachers should receive computer education is an open topic. My hope for the future is tied to my conviction that *computers are for all teachers* will prevail.

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This book and others in the series are made available at low cost through the contribution of the Phi Delta Kappa Educational Foundation, established in 1966 with a bequest by George H. Reavis. The Foundation exists to promote a better understanding of the nature of the educative process and the relation of education to human welfare. It operates by subsidizing authors to write booklets and monographs in nontechnical language so that beginning teachers and the public generally may gain a better understanding of educational problems.

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