5-1967

An Investigation of Computer Assisted Instruction

Dennis C. Jensen
Utah State University

AN INVESTIGATION OF COMPUTER ASSISTED INSTRUCTION

by

Dennis C. Jensen

A seminar report submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF EDUCATION

in

Elementary School Administration

UTAH STATE UNIVERSITY
Logan, Utah

1967

ACKNOWLEDGMENTS

Appreciation is gratefully extended to my Committee Chairman, Dr. Oral L. Ballam, for his helpful suggestions, guidance, and criticisms in the preparation of this report.

Appreciation is also extended to Dr. Malcom Allred and Professor Arthur Jackson, members of my committee, for their support and leadership which aided greatly in writing this report.

I am also deeply indebted to my wife, Lorna, for her assistance and encouragement in preparing this paper.

Dennis C. Jensen

TABLE OF CONTENTS

INTRODUCTION

Background

It appears that technological innovations have increased pressures on all elements of society including education. The forces of change are creating pressures on the organization structure, teaching content, and teaching methodology. One of these technological innovations is the computer. Educators have shown increasing interest in the use of computers for classroom teaching, especially within the past few years, and many basic questions have been raised.

Statement of the problem

It was the purpose of this study to investigate the role of computer assisted instruction in our education process with emphasis on individualizing instruction, teacher's role, limitations, and future prospects.

Significance of the problem

Due to organizational changes and increased population, schools are faced with larger numbers of students. Rising costs and increasingly complex subject matter are also confronting educators. To meet these challenges schools must be more effective in the teaching process. There is some question as to whether the conventional buildings and "traditional" methods of instruction will meet all the needs of the students today. Computer assisted instruction could be a means of reaching more educational objectives and more of the needs of our students in the future.

Limitations

This study was limited to the area of computer assisted instruction. The role of the computer in scheduling, counseling, use in the instructional media center, or varied uses in a school district central office was not a part of this study. No attempt was made to study the costs of computer assisted instruction nor the intricacies of how a digital computer operates.

Definitions

The following terms will be used in this study as defined.

CAI---------------Computer assisted instruction

Hardware--------- The actual computer machinery

Software---------- The programs that are written for the computer

Terminal

Response station---Terms used to indicate the junction where student

Console and machine meet. Each may serve for both information display and student response.

INDIVIDUALIZING INSTRUCTION

The idea of individualized instruction has been prominent in American education for several years. Studies in psychology have shown that individuals differ in their rates of learning, in their abilities, and often even in their general approaches to learning. Unfortunately, the cost of providing individualized instruction that adapts to these differences is prohibitive if it depends on the use of professional teachers. For example, consider what it would cost to reduce the present classroom size to four or five students per teacher (Suppes, 1967). Cost

Several writers, including Charp (1966), Janssen (1966), and Suppes (1967), believe the computer to be the most practical hope for a program of individualized instruction under the supervision of a single teacher in a classroom of 25 to 35 students. One basis for this practical hope is the rapid operation of the computer, which enables it to deal on an individual basis with a number of students simultaneously.

The computer's ability to handle student differences in learning rate, background, and aptitudes offers exciting possibilities for individualized instruction.

There are three systems or levels at which a student and computer may interact: (1) Individualized drill-and-practice system, (2) Tutorial system, and (3) Dialogue system.

Suppes (1967) describes them briefly as follows.

Individualized drill-and-practice systems

This kind of interaction between the student and the computer program is meant to supplement the regular teaching process. After the teacher has introduced new concepts and ideas in the standard fashion, the computer provides regular review and practice of basic concepts and skills. Exercises can be presented to the student on an individualized basis, with the brighter children receiving harder than average exercises, and the slower children receiving easier problems. One important aspect of this individualization should be emphasized: In the drill and practice computer system, a student need not be placed on a track at the start of school in the fall and held there the entire year. At the beginning of each new concept block--whether in mathematics or in language arts--a student can be "recalibrated" if the results indicate that he is now capable of handling more advanced material.

Elementary mathematics, reading, and aspects of the language arts, such as spelling, elementary science, and beginning work in a foreign language, benefit from standardized and regularly presented drill and practice exercises.

Tutorial systems

In contrast to the individualized drill-and-practice systems, tutorial systems take over the main responsibility for helping the student to understand a concept and develop skill in using it. Basic concepts such as addition or subtraction of numbers, can be introduced by the computer program in such systems. The aim is to approximate the interaction a patient tutor would have with an individual student.

A child is introduced to a new concept and new exercises as soon as he demonstrates a clear understanding of a preceding concept.

Dialogue systems

Dialogue systems are computer programs and consoles that enable the student to conduct a genuine dialogue with the computer. Dialogue systems are not completely implemented yet because of some teachnical problems. A computer must be devised that can "understand" oral communication.

One might inquire how instruction may be adapted to each student's needs. Filep (1967) suggests this may be accomplished by displaying sequences of varying difficulty, providing remedial sequences when diagnosis based on responses indicate the need, altering sequences and presentation modes, transferring control of the machine to the learner, and giving the learner opportunities to respond in many different ways. Data obtained about the student, prior to his using the terminal, may also be indirectly incorporated into the sequence--such factors as vocabulary skill level, mathematical aptitude, reading comprehension levels, etc.

Charp (1966) further indicates that students can be branched forward, laterally, or backward through subject material depending on the basis of their response to content questions. The capable student can be challenged and his learning accelerated, while the student who may have difficulty in mastering the subject matter can proceed at his own rate of speed.

The computer can provide lessons tailored to individual needs so that a student can regulate the rate of inculcation, as it were, in terms of his own ability to progress. The imparting of information can be done in writing, through still pictures, moving pictures, voice, or combinations of these. Responses can be made by pressing buttons, operating typewriter keyboards, by voice, or by using other alternatives made possible by the electronics industry. One of the fascinating possibilities is that both students and teachers can be supplied with a record of progress at any point in the curriculum and the teachers can get reports on the progress of students so as to keep the faculty apprised of student development and show up problems and difficulties. Another possibility lies in simulation of the decision-making process in such activities as running a legislature, operating a business department, or even conducting a laboratory experiment. Moreover, the equipment need not be in the same community as the student. An established information center, used for simulation, can be reached by telephone. It is already possible for a student to telephone a computer and obtain a formula, receive language instruction, see a film, or conduct a chemical experiment (Stark, 1967).

The computer stores programmed material and feeds it to the student step by step. But the computer is far more than a mechanical gadget that simply uncovers items to be learned. For one thing, it is highly adaptable. It responds instantly, on its own, to the individual's needs. If he has trouble at any point, for instance, it can "branch" automatically to another series of steps to help him over his difficulty. Or it can analyze his learning problems, using stored information about his earlier progress and thus alert a teacher to any persistent troubles he might have.

Unlike the simpler machines, the computer doesn't restrict the student to a series of tiny steps that become boring once the novelty has worn off. It is versatile and can offer instruction in writing, by voice, or in pictures. It can, for that matter, carry on a typed dialogue, answering questions in such a sophisticated way that in one experiment a group of students were convinced that they were communicating with a real person (Changing Times, 1967).

The electronic computer has the capability of presenting a rich branching program that would be too unwieldy in book form, and energetic experimentation with computer based instruction is going on. The computer can take into account all past performance of the student and all information about him that has been fed in, provided someone has written a program sufficiently complex to involve all these factors.

The computer's most important potential is to make learning more an individual affair. Students will be less subject to regimentation and moving in lockstep fashion because computer programs will offer highly individualized instruction. Suppes (1967, p. 17) refers to his work at Stanford, saying, "We estimate that the brightest student and the slowest student going through our tutorial program in fourth grade mathematics have an overlap of not more than 25 percent in actual curriculum."

Science Newsletter (1961) reported on another study. A course in miniature geometry, based on two definitions and four axioms was given to twenty students. The machine sped one man through in 33 minutes but took 78 minutes to make certain that another fellow mastered the subject.

According to Caffrey:

> The computer, far from providing inhuman and blind assistance, can as a matter of fact provide much more highly individualized instruction. It is possible for 30 pupils all to be using the same computer and all working at different speeds or levels of difficulty. Only a pupil-teacher ratio of one to one can be compared to what it is possible to do. (Caffrey, 1967, p. 28)

There is some concern that CAI will become completely impersonal and regimented. Zinn (1966) indicates that self study materials prepared for use in automated systems cannot possibly anticipate all the questions and special difficulties which arise; the teacher will always be on hand to assist students whose individual requirements and interests have not been met by the preplanned instruction sequence. In systems where data on individual student performance are immediately available to the teacher, he may interrup a student to provide guidance or additional suggestions where appropriate. A well designed instructional system increases the individuality of the learning situation and the personal interaction between student and teacher. Computer assistance should be used as a tool by curriculum planners, materials authors, and teachers to more effectively achieve their educational objectives.

Filep (1967) feels, however, that a certain amount of impersonalization is advantageous and should not be counted out as a positive attribute of CAI.

He states:

> The impersonal nature of the man-machine relationship is relevant to any discussion of computer-aided instruction. Undoubtedly, many people will compare the capabilities of the computer-based teaching terminal with those of the classroom teacher. Those involved in computer-aided instruction would agree that an attractive, smiling, receptive teacher may indeed

> be able to impart more knowledge. However, any comparison study probably would show results that would indicate no significant differences between the two teaching sources when the teacher, using the same visual devices available at the terminal, follows identical teaching sequences. An ineffective teaching sequence, whether presented by a teacher or a terminal, is a poor sequence.
>
> The capability of providing impersonal, individual instruction diagnosis via the terminal cannot be underestimated. Many students, whether they be adolescents or adults, are reluctant to expose their lack of knowledge to other people. They may, if they do not understand, ask to have a statement repeated twice, but seldom thrice. These students are handicapped too by the possibility that the teacher will not be providing an alternate statement based on some perception of what the individual does not understand, but merely a verbatim repeat of the original statement. Even if the individual student should patiently request the same information ten times, unquestionably the speaker would have departed or refused further verbalization; not so the computer. The computer-based terminal has infinite patience; it can repeat if requested and may permit a person to take as long as he wishes before responding to any inquiry. (Filep, 1967, p. 106-107)

Silberman (1966, p. 203-204) concurs, saying, "One of the greatest advantages the computer possesses may well be its impersonality, the fact that it can exhibit infinite patience in the face of error without registering disappointment or disapproval, something no human teacher can ever manage."

Filep (1967) further suggests certain subtle but meaningful dimensions are evident when using the terminals, especially the interaction between student and machine. An individual gains a sense of "molding" his instruction much the same as a potter molds clay. The presentation is responsibe to his replies, and he can see a set emerging which is modified by his input. The "hands-on quality" of typing and/or using a light pen also gives him feed back through the tactile senses. These experiences may fulfill a need for contemporary man to be a "craftsman," or at least actively participate in the highly personal process of learning. Perhaps in this interaction, the individual is creating his instructional "work of art" from start to finish as did the craftsmen of old with their products. The person sitting at the terminal is involved in the process of creating his instructional "urn."

Every human being has a different learning style: some people gather knowledge quickly, others slowly or not at all. Everybody comes into a learning situation with a different background, different vocabulary, different attitude, and a different supply of what is called intelligence. In a typical sixth-grade classroom, for example, the mental age level of the pupils, according to a widely accepted study, ranges from 9 years to 16 years. But measured intelligence is no true indication of the capacity to learn. There is, however, some agreement among psychologists that a student, whatever his supply of intelligence may be, seems to learn best when his lessons are tailored to his own pace of learning. The computer system does adjust to each pupils personal speed (Bowen, 1967).

Janssen (1966) feels that in the long run, the promise of the new technology is great. It is the promise of individual instruction where everyone learns, but not at the expense of anyone else. The promise of the computer is to enable each student to stretch his abilities to the farthest point.

Perhaps the chief value of the emerging educational technology is that, properly researched and developed, it has the potential for giving the teacher time for the really important things, the things that cannot be done by a book or by a machine.

There seems to be little reason to think that computers will ever replace teachers or reduce the number of teachers needed. The thrust of CAI is to raise the quality of education (Suppes, 1967).

Experience shows that students learn from computer based instruction. Only further experience can tell us whether it will be an effective and economical addition to the teaching system (May, 1966).

THE TEACHER'S ROLE IN CAI

The new machines force the classroom teacher into a unique new role. This new role will be to work individually with all students on whatever problems and questions they may have in assessing and handling the new concepts. According to Suppes (1967) teachers will have greater opportunity for personal interaction with students.

Silberman (1966) feels that the teacher's role will be drastically altered, but the teacher will certainly not be replaced. The computer will have less effect on teachers than did the book, which destroyed the teacher's monopoly on knowledge, giving students the power to learn in private, and to learn as much as, or more than, their masters. The teaching technologies under development will change the teacher's role and function rather than diminish his importance.

Janssen (1966) indicates the teacher's role will be very different. He will be concerned with the development, convictions, and social actions of his students. The teacher will be student oriented and not subject oriented.

Loughary (1967a) goes on to say:

> As teachers learn to use the expanded resources and support systems to provide more individualized instruction, pupil demands will increase with regard to both the scope and specificity of education. Stated in another way, one outcome of the educational revolution will be an increased emphasis on pupil-oriented instruction. Instead of organizing and orienting teaching to his own interests, convenience, and view of the subject, the teacher in the "new" education

> will be required to serve the learning needs of individual and groups of pupils as they actually exist.
>
> As the expectations of teachers change, teachers will modify their own expectations regarding their professional roles. They may expect and ask for more time to think, for extended time to develop and refine resource materials and systems, for increased opportunities to continue their own education, and for a large responsibility in determining the operation of the educational enterprise.
>
> The increased efficiency of education will result in increased competitiveness among educators. Because of such things as increased cooperative teaching, greater specificity of teaching objectives, and more scientific teaching procedures, the outcomes of teaching will be easier to measure. As a result the relative contributions of individual educators will manifest themselves more clearly and teachers will naturally expect and insist that salaries and professional opportunities be commensurate with such differences. (Loughary, 1967a, p. 206)

The teacher's physical and mental capabilities will be amplified, stretched, and strengthened by marvelous equipment which will aid and abet him in the diagnosis of learning needs, the transmission of knowledge, imparting of skills, the motivation of learning, and the evaluation of educational results. These devices will eliminate many of the chore aspects of teaching and will be ideally suited to handle the repetitive exercise and reviews necessary to foster learning (Hill, 1967).

Bowen (1967) sees the teacher in a unique new role. In talking about the number of drill and practice problems programmed into a computer for an elementary arithmetic class he maintains there is no way a single human teacher can present 96,000[1] drill and practice problems to a class, let alone mark the

---

[1]Please refer to page 18 for further explanation of this number.

results and give review exercises. Nor, in a computerized class, is there any reason why the teacher should. "A teacher who only dispenses information can be dispensed with," says Harold Gores, president of the Ford Foundation's Educational Facilities Laboratory. "From now on, things should be taught by machines. And the teacher is raised to the level of meanings. Things from machines, values from people." That is, in the simplest terms, D-O-G is dog, whether it comes from Miss Jones or a computer, but whether or not all dogs are created equal is a matter for the pupil and Miss Jones.

The fields of instruction and evaluation are exactly the fields in which the use of computers may offer the best service to students and to overall purposes of education.

Fincher (1967, p. 147) contends, "It will be all the more important that the public understand that computers are of use in these areas because they can perform faster and more efficiently the same tasks that are now being performed by the human instructor."

Computers can provide more effective methods of performing tasks of drudgery and free teachers for their professed tasks. If the computer can relieve the instructor of the tasks of scoring, grading, recording, and reporting, classroom instruction will not be depersonalized.

Fincher (1967, p. 148) further states, "If the student perceives the teacher's role as one of facilitating learning rather than transmitting information, both the teacher and the student will enjoy their respective tasks more."

Silberman agrees, commenting:

> By taking over much--perhaps most--of the rote and drill that now occupy teachers' time, the new technological devices will free teachers to do the kinds of things only human beings can do, playing the role of catalyst in group discussions and spending far more time working with students individually or in small groups. In short, the teacher will become a diagnostician, tutor, and Socratic leader rather than a drillmaster--the role he or she is usually forced to play today. (Silberman, 1966, p. 205)

The computer can bring the best teachers, the most carefully planned curriculums, key books, and manuscripts to each classroom and to each teacher and pupil. Coupled with the new role of the teacher as an educational diagnostician--as a teacher of thinking and living, not just a transmitter of data--the new approach to learning should keep us from developing a mechanized classroom (Janssen, 1966).

The preparation of teachers to meet the challenge of their new role seems to be a concern which justifies attention, however. Changing Times (1967) agrees with this idea, indicating that the new machines will free the teacher at last to teach students individually and creatively. The trouble though--and this is another of the really serious problems--is that nothing is being done to train teachers to use the complex new technology. Teachers colleges, even some of the best, are still using old techniques, ignoring the transformation that has already begun in the schools.

Loughary (1967b) feels that it is quite obvious teacher preparation and training will have to change. He feels that it isn't a question of whether the requirements of teaching will change, but rather one of how much time there is to prepare for changing requirements. He further indicates that students who have experienced truly individualized and enriched instruction and immediate feedback of the results of their work with computers will demand rich and meaningful instruction.

Loughary (1967b) envisions a support team for the teacher consisting of content research specialists, media specialists, systems specialists, and engineers. The teacher's primary responsibility would be to determine what she wants her pupils to learn. The support team would help her with the how, but she must understand from her own training the capabilities of computers and new media and how she can use them. The content researcher would determine the most appropriate materials for the teacher's instructional objectives. The media specialist would assist by determining whether the material is better presented by audio-visual methods, programmed material, or, perhaps, television. The systems specialist would be responsible for putting all the various resources together; his task is to anticipate and think through all of the "what happens if" and "what should be done when this takes place" questions. It is one thing to give the wrong assignment to a group of students now and to be able to correct the assignment the next day. It will be quite another to program individualized assignments for a whole class for a whole term and then find out that a mistake has been made.

Stated in the broadest terms, the teacher becomes a trouble-shooter, both intellectual and mechanical. And it appears there is plenty of both kinds of trouble in any computer classroom.

LIMITATIONS AND CAUTIONS

The day of electronic data processing in the business of education has arrived. To hear some computer-boosters talk, the schoolman who wants to be "with it" may feel that he ought to run right down to his corner computer center and buy one today.

But before getting caught up in the razz-ma-tazz of data processing as a miracle-working cure-all, School Management (1966) suggests consideration of the following:

> -Computers cost money, usually lots of money.
>
> -At least some of the school personnel will have to be retrained to run a data processing service. New, trained personnel may have to be hired.
>
> -Computers can't do the impossible--they can't replace desks for example.
>
> -People do some things better than computers. (Did you ever know of an irate parent who was calmed down by a machine?) (School Management, 1966, p. 49)

Along with these considerations there are others that must be explored. Bowen (1967), Brann (1966), Changing Times (1967), Dick (1965), Riesdesel (1967), and Stark (1967), see the greatest limitation in the area of writing programs.

As computer pioneers are finding out, no matter how fast or how well a programmer writes a program, at least in these early days, the students are always ahead of him.

Bowen (1967) reports:

> Last year, at Grant Elementary School near Brentwood, Suppes had 30 children a day working on computerized math drills at a simple teletypewriter terminal--a machine with a keyboard, but no cathode tube or projection screen. Most of the children were able to learn two years' worth of math in one year, but simply to keep the 30 pupils busy only five minutes a day over the 160 days of the school year, the programmers had to develop 96,000 exercises, a chore that took some 1600 man-hours. (Bowen, 1967, p. 78)

Riesdesel (1967, p. 29) concurs when he says, "Writing CAI materials takes a long time. Ways of improving writing speed without hurting quality must be explored. Can programs be developed more efficiently?"

Changing Times (1967) indicates the biggest problem of all, as it has been all along in educational TV and as it was with the first teaching machine, is the question of what goes into the hardware. No matter how easily a student may be able to operate a video tape replay machine or a computer keyboard, what he learns will depend directly on the instructional material--the "software"--that goes into the machine in the first place. "GIGO" is a current slogan in computer circles: "Garbage in, garbage out."

Brann (1966, p. 81) further emphasizes this idea when he reports, "The computer has one major drawback as a teacher. It cannot answer student questions unless it has been programmed for them. A computer is only as good as its programmer. That's going to be the heart of this type of instruction. You've got to have good writers."

Hoffman (1965) goes on, suggesting the most important point to consider in developing a computer-oriented educational program is to be sure that one has or trains an enthusiastic and knowledgeable person to direct the computer activity. Especially if the computer is in the school, this person should have a broad and thorough knowledge of computers and their uses. Such a person needs to have some of the qualities of a good salesman (or a good teacher!) to do an adequate job of developing the computer program.

In the development of computer activity it is wise to seek the advice of knowledgeable people who have been in the computer field for a number of years. They can be helpful both in the selection of equipment and in offering suggestions about curriculum.

Speaking generally, it is already clear that technology can promote both the effectiveness and the flexibility of teaching and thus in a very real sense improve the productivity of the now over-burdened teacher. But it is necessary, of course, that the equipment be properly programmed. Its contribution depends entirely on what is put into the machine, and there are many indications that the early stages of technological development in education have been hampered by poor programming as well as the experimental character of the equipment. Moreover, there is a great deal of concern about the need for maintaining control of programming by the educational community. It appears that all too often this crucial responsibility falls to the hardware manufacturer, who is ill-equipped to perform it. As John H. Martin, school superintendent of Mt. Vernon, New York, says, "The center of gravity for educational change is moving from the teachers college and the superindent's office to the corporate executive suite." (Stark, 1967, p. 197)

Suppes (1966) sees a slightly different problem, indicating the principal obstacles to computer-assisted instruction are not technological but pedagogical: how to devise ways of individualizing instruction and of designing a curriculum that are suited to individuals instead of groups. Certain obvious steps that take into account different rates of learning can be made with little difficulty; these are the main things that have been done so far. "We have still, however, cut only a narrow path into a rich jungle of possibilities. We do not have any really clear scientific idea of the extent to which instruction can be individualized. It will probably be some time before a discipline of such matters begins to operate at anything like an appropriately deep conceptual level." (Suppes, 1966, p. 208)

Zinn (1966) sees the greatest limitation of computer instruction as the restriction on student response formats which can be interpreted by the machines. It is difficult for computers to process and evaluate essays, complex physical constructions, and facial expressions. Lack of organization of the subject (and the author) may make computer presentation difficult where live, individual instruction can be successful.

Lack of social integration is another problem that must not be overlooked. Caffrey (1967) suggests that the school must provide for the social integration of the individual. Students working in groups, with human teachers, learn things that cannot effectively be programmed: they learn how to accommodate themselves to the different abilities and interests of others, how to reason something out, to achieve consensus in discussion, to tolerate variety, to exploit the unexpected, to express thought in ways which convince. These things must be provided in the school curriculum.

Loughary (1967b) looks at a problem of CAI from another point of view:

> The dichotomy between man and machines operates even more frighteningly in safeguarding the rights of individuals. A computer may take in every facet of a pupil's being from health to grades to psychological services to attendance to work placement, and store them in its memory as no human teacher can; but, it will also store poor motivation, arrests for thefts, and an alcoholic father. Such information is vital to the teacher while the child is in school but, the same information, available to an agency establishing the pupil's security clearance for a job some six or eight years after that individual's high school graduation, can be completely misleading, irrelevant, and invalid in terms of his ensuing growth and development. Of special concern is the efficient manner with which a computerized nationwide information-retrieval system could retrieve information without first obtaining the permission of the individual. The problem is compounded not only by the issue of who has a right to know what about whom but also, who has the right to decide who has the right to know what about whom.
>
> There is as yet no answer to that last question, but there is the possibility that educators and laymen, at different levels, will fail to overcome threats posed by a new technology they don't understand. The danger is in their possible unwillingness to learn what needs to be learned, and thereby to fail to participate in decisions regarding the function of man-machine systems in education. (Quoted in Ferrer, 1967, p. 145)

There is also a danger that technological change may move too fast. Dozens of companies, alive to a new market, are impatient to sell. And now that it's becoming fashionable for schools to innovate, some administrators may be getting overly anxious to buy. Congress recently put up some money to promote creativity in education. "But too many of the requests from local schools, say officials, have been for money to buy mechanical gadgets, not enough for money to use in developing creative teaching programs." (Changing Times, 1967, p. 28)

Silberman (1966) also suggests caution about moving too rapidly when he comments:

> The greatest fear of firms like I. B. M. and Xerox is not that someone may beat them to the market, but that some competitor may rush to market too soon and thereby discredit the whole approach. A number of firms, several with distinguished reputations, did precisely that five years or so ago when they offered shoddy programs to the schools and peddled educationally worthless "teaching machines" and texts door to door. (Silbermann, 1966, p. 122)

Although restraint is not always possible in every sales situation and with every salesman, computer suppliers and manufacturers are trying to avoid enthusiastic selling tactics until the equipment is simple to operate, extremely reliable, and competitively priced. They probably recall with pain, as do schoolmen, what happened a few years ago when 80 companies rained down teaching machines on the school field so heavily that they almost washed out programmed instruction.

A lot of school administrators haven't made up their minds yet about the electronic course they want their districts to follow. That's understandable and prudent. But it could be damaging to public schools everywhere if school district authorities confuse deliberation with a defense of the status quo, even when this may be a comfortable thing to do. The danger is that some administrators and school boards might be tempted to draw a mental circle around their traditional educational programs and shut out what is new and different. Minds that aren't made up don't cause trouble: minds that are closed do (Cohodes, 1966).

Computer systems in education must work with a much higher degree of reliability than is expected in computer centers where the users are sophisticated scientists, or even in factory-control systems where the users are experienced engineers. If in the school setting young people are put at computer terminals for sustained periods and the program and machines do not perform as they should, the result is chaos. Reliability is as important in schools as it is in airplanes and space vehicles; when failure occurs, the disasters are of different kinds, but they are equally conclusive (Suppes, 1966).

Bowen (1967) further emphasizes this point calling an electronic teaching device a fallible instrument, subject to the vagaries of overheated circuits and faulty wiring.

At this stage of its development, it also has severe limitations as a tutor. In most instances it can act as little more than a lightning-fast memory device, able to respond only to those words, numbers, instructions, and questions which have been painstakingly programmed in. And while a clever programmer can make a computer that couples a teletypewriter with audio-type response behave as if it were carrying on a conversation with a human, actually the machine is just picking out one or two key words and giving back canned replies. As of today, it has very little flexibility.

Becker (1967) somewhat summarizes the limitations and cautions of CAI thusly:

> Computer-assisted instruction represents an example of more promise than delivery. A realistic appraisal of CAI would tend to indicate the following:

-Computer-assisted instruction currently utilizes hardware that is a synthesis of the digital scientific computer, the data processing or business computer, the process control computer, and the communication control computer. At the present time the synthesis of these four approaches demands a software package which is greater than the sum of its four parts. To date this software capability has not been developed.

-The author languages necessary for writing instructional materials to be used in the computers are too inflexible. To date a flexible language has not been developed.

-Too few CAI experimental studies are under way. The halfdozen exciting studies currently being conducted are encountering many difficulties with both the hardware and the software. For example, the audio capability of CAI is still fraught with problems.

-The research dealing with learning theories and the behavior of the learner is quite primitive. Too little is known about the potential effects of CAI on the learner.

-The bulk of the instructional materials being used for CAI experiments are no better and often not as good as existing workbooks.

-Curriculum makers have not developed the ability to state learning in terms of specific behavior or outcomes.

-The technologists (including our large companies) have not provided much help in evolving a new systems approach to instruction in which the teacher is the manager of the system. (Becker, 1967, p. 238)

It appears then, that there are still many problems to be overcome with CAI and one should be aware of these when working with or anticipating involvement in computer assisted instruction.

A LOOK TO THE FUTURE

Just exactly what will be on the future list of child and computer and teacher and machine is surely one of the most prickly and provocative problems facing American education in the next decade. The technological potential of aiding a disadvantaged child, of individualizing instruction, of predicting who will be a dropout, of forecasting who will get into college, of judging what is a good curriculum--indeed of making the best curriculums--is not only limitless but startlingly imminent. The first large-scale general purpose digital computer, the Mark I, was completed in 1944 and, after 20 years, has already been retired to the Smithsonian Institute. It is not only feasible but reasonable certain that within the next 10 years most classrooms will have some form of computerized education--and it may be a great deal sooner (Loughary, 1967b).

Janssen (1966) sees a computerized classroom as being competitive with traditional techniques perhaps in the fall of 1969 and most certainly in the fall of 1970. Use of computers will be widespread within 10 years, and eventually they will be used in all elementary and secondary schools. Technology within 10 years essentially can take over teaching subjects, the drill, the facts, and so on. There is little doubt that development of school computers will be concentrated.

According to William T. Knox, a scientific adviser to the president, "By 1980 perhaps half the public school districts and all of the colleges and universities in the U. S. will be employing remote terminal, direct access computers." (Changing Times, 1967, p. 27)

Dr. R. Louis Bright, associate commissioner of education for research, says that the computerized classroom will be a practical matter, technically and financially, for any regular school system within three or four years. A community planning to build new schools, he warns, must take the fact into account.

But educational people, says Dr. Bright, are notoriously slow to accept change. Whereas in medicine, innovations are often adopted universally within two years, the lag in education runs as high as thirty years.

Suppes (1966, p. 207) says, "One can predict that in a few more years millions of school children will have access to what Philip of Macedon's son, Alexander, enjoyed as a royal prerogative: the personal services of a tutor as well-informed and responsive as Aristotle."

Janssen (1966, p. 72) in describing the school of the future suggests, "It will be a school in which the teacher uses the computer as the most sophisticated teaching tool of all, a tool which permits teaching excellence to be the common experience of all students and one which permits each student to progress at his own rate."

Schools can't assemble a total curriculum from material already written for computer presentation, but according to Zinn (1966) the day is coming soon when nearly all areas will have useful exercises available in the computer. Authors are busy writing and testing material in many areas. Some of the materials are in the format of linear and scrambled textbooks, often little more than a scored quiz. Others are in inquiry or simulated environment pattern. The level varies from preschool to professional training.

Swets (1965) in describing computers in CAI indicates that computers as teaching machines can present lesson materials, and accept student responses, in several forms. A computer can type on an electric typewriter, generate text and pictures on a television screen, and control a slide projector and tape recorder; the student can type, write with a "light pen" on the television screen, or respond by means of some special device. The computer can keep various scores, and use them to select an appropriate path through a lesson for any particular student.

The Audiovisual Instruction staff (1964) assesses the future of the computer in CAI when they see four basic properties or potentialities. It can serve:

> -As a mediating and controlling device for teaching machines--devices used for self instruction.
>
> -As a stimulator--generating chance variables, making logical decisions based on student's input--helping to train students in processes of decision making.
>
> -As an information bank, aiding in the diagnosis of the learning problems of individual students and helping the teacher or counselor to prescribe appropriate teaching strategies for the resolution of those problems.
>
> -As an instructional tool to help extend human cognitive capacities. It is used in this way to teach students computer mathematics, computer programming, and other appropriate subject matter. (Audiovisual Instruction Staff, 1964, p. 150)

The computer--with its ability to evaluate, individualize, to store up and present vast quantities of material--may turn out to be the only means by which the country can cope with the explosive growth of what has come to be called the Knowledge Industry. On any morning 55 million Americans are in school. Outside the formal classrooms, big business is continually training or retraining employees; and 20 million preschoolers are being borne down upon by psychologists who feel these little children should stop frittering away their time and start making organized use of those crucial learning years. Science continues to push out the boundaries of what an educated man must know. Somehow this bursting mass of information must be stored where man can quickly get at it, and ultimately it has to be put across to students in ways they can understand (Bowen, 1967).

Changing Times (1967) is optimistic about the future of CAI, suggesting that the art of programming for the new technology is still in its infancy, and may take years to develop. No doubt the breakthrough will come. When it does, chances are that it will bring with it new discoveries about learning itself. The result will be schools gloriously different from those we have today.

For one thing there'll be no such thing as failure. Bright students might do a program in one-fifth the average time; students at the bottom of the class might take two or three times the average number of hours. But everyone will eventually pass the course, and know what's in it--it's prepared that way.

For youngsters who've been used to failure, or who come from poor neighborhoods where success of any kind is rarely expected, the experience can be dramatic.

No one will be lost in the crowd. The machine he works with will respond automatically to his individual academic needs. And the teacher, free from routine class work, will be available at his call.

Whenever this revolution really does take hold, chances are that we'll have at last what educators have been talking about for years--the truly child-centered school.

Bowen (1967) feels that the computer will even be more humanized and carry on an actual dialogue. He refers to select experiments where computer programmers are moving their machines closer and closer to human consciousness. At Stanford one computer, by matching the sound waves in a human voice to wave forms already programmed in, can recognize some 200 words spoken directly to it through a microphone. At General Electric's laboratory in Santa Barbara and at M. I. T., other computers are inching toward the ability to understand and reply to questions they have never before received.

There are probably many ways and techniques of using a computer to teach any given lesson. Richardson (1966) gives somewhat of an idea in the following description.

> Here is how a teacher might some day conduct a classroom lesson in mathematics with elementary school students. He wants to demonstrate the meaning of a non-trivial mathematical concept. Through a teletype in his classroom, he calls upon a digital computer located many miles away. He thereby obtains access to a computer program--called TELCOMP, for example--which serves as a central tool in the mathematics laboratory. He requests the program to call up a demonstration problem that he had prepared at the teletype last week.
>
> The teacher specifically wishes to introduce the concept of "function as ordered pair." The discussion is centered around utilizations of the demonstration problem for testing hypotheses about number pairs. At various points in the discussion individual students will operate the teletype terminal. Sometimes they will type in numbers as arguments for computation; but they will also type in and execute small

> computer programs. These programs represent the students' tentative hypotheses on what mathematical law governs the relationships among the number pairs typed out thus far. (Richardson, 1966, p. 84)

There is a feeling also that CAI will not only have value in teaching subjects, but the actual manipulation of the computer at the terminal and understanding something about its operation are of extreme value. Broderick (1967) makes reference to this, commenting:

> Research conducted in the United States indicates that 85 percent of the students leaving high school now will come into direct and significant contact with computers during their working lives. This indicates the scale of the problem that is posed by the second industrial revolution. (Broderick, 1967, p. 712)

According to Dr. Jerome B. Weisner, Dean of Science at Massachusetts Institute of Technology:

> The computer, with its promise of a million-fold increase in man's capacity to handle information, will undoubtedly have the most far-reaching social consequences of any contemporary technical development. The potential for good in the computer, and the danger inherent in its misuse exceed our ability to imagine. . . . We have actually entered a new era of evolutionary history, one in which rapid change is a dominant consequence. Our only hope is to understand the forces at work and to take advantage of the knowledge we find to guide the evolutionary process. (Quoted in Ingraham, 1967, p. 51)

In summing up the outlook for the future of CAI, Becker (1967) issues a challenge. Humanizing individuals is what education is about. For the first time man has the capacity of using technology to achieve this end. Within our grasp is the individualization of instruction for the learner, thus making it possible to achieve maximum opportunity for all of the learners in our schools. It can be done, and at a much faster rate, if teachers can be brought to see and accept the revolutionary aspects of a new and exciting role, if the gap between promise and delivery is closed, if existing institutions begin to cooperate with intervening forces, and if they are willing to commit more dollars to the cause.

Technology will have an impact. We can wait for tomorrow but our children cannot. Some of us are already deeply involved. Our experimental classrooms already reflect tomorrow. Others will follow, some soon, some later. The change is inevitable. How long it will take us to meet the challenge, and how well we do meet it, is, at this point, unanswerable.

Suppes (1967) emphasizes that no one expects that students will spend most of their school hours at consoles hooked up to computers. They will work at consoles no more than 20 to 30 per cent of the time. All teachers everywhere recognize the help that books give them in teaching students. The day is coming when computers will receive the same recognition. Teachers will look on computers as a new and powerful tool for helping them to teach their students more effectively.

SUMMARY AND CONCLUSIONS

Computer assisted instruction is a relatively new idea in our education process. There has been a limited number of studies done to the present time, but a great many more are currently being conducted. A review of the literature, however, seems to indicate and warrant the following conclusions:

1. At the present time there are three systems by which a student may interact with a computer: (1) Individual drill and practice system, (2) Tutorial system, and (3) Dialogue system. The dialogue system, as yet, has not been developed and used as extensively as the drill and practice system or the tutorial system.

2. It is felt that the use of computers in instructing students in the classroom will be of great assistance in individualizing various programs for the particular students. A student using a computer can be branched forward, backward, or laterally, depending upon <u>his</u> particular needs.

3. The consensus of opinion in the review of literature is that the impersonalization of the computer in the teaching process is valuable and should be considered a positive attribute of CAI.

4. The teacher's role will greatly change with CAI. He will become more of a diagnostician concerned with the social actions of his students. Many of the chore aspects of teaching will be performed

by the computer which will free the teacher to play the role of catalyst in discussions. The teacher will be able to spend more time with students individually and in small groups.

5. Changes must be made in teacher training programs, both for prospective teachers and in-service teachers, to prepare them for their new role.

6. Even though experimenters and writers in the field of CAI are optimistic about the use of computers, there are some limitations and cautions to be considered:

a. The writing of good programs appears to be the greatest concern of CAI at the present time.

b. Program writing is a time consuming job and must be done by well trained people.

c. The computer can only reproduce what has been programmed in, so the writers must anticipate the needs and problems confronting students and write programs of high quality to meet these needs.

d. Caution is also expressed about technological innovations moving too rapidly and, therefore, flooding the market with new ideas before they are properly and thoroughly researched.

7. What the future holds in store for CAI is somewhat uncertain at this time. However, it is felt that the computer will play an important role in the teaching-learning process within the next decade. Because of

the knowledge explosion and the impact of technology upon our society, many writers see the computer as a valuable tool to aid the teacher in the education of our citizenry.

LITERATURE CITED

Audiovisual Instruction Staff. 1964. Information science: The computer as an instructural tool. Audiovisual Instruction 9:406-408. September.

Becker, J. W. 1967. It can't replace the teacher yet. Phi Delta Kappan 48:237-239. January.

Bowen, E. 1967. Computer as a tutor. Life 62:68-70. January 27.

Brann, J. 1966. Now teaching by computer. Science Digest 59:78-81. April.

Broderick, W. R. 1966. Computers and school. Times Educational Supplement 2680:712-714. September 30.

Caffrey, J. 1967. Tomorrow's school in the electronic era. American School and University 39:28-30. March.

Changing Times. 1967. Computerized classrooms are almost here. 21:24-28. March.

Charp, S. 1966. Computers solve math instruction problems. Nations Schools 78:79. October.

Cohodes, A. 1966. Computers are pointing their digits at schools. Nations Schools 78:63. October.

Dick, W. 1965. The development and current status of computer based instruction. American Educational Research Journal 2:41-54.

Ferrer, T. 1967. Review of Loughray's, Man and machines in education: All systems go? Phi Delta Kappan 48:244-246. January.

Filep, R. T. 1967. Individualized instruction and the computer. AV Communication Review 15:102-112. Spring.

Fincher, C. 1967. Of students, professors, and computers. School and Society 95:144-148. March 4.

Hill, F. W. 1967. Shape of things to come. American School and University 39:53-54. March.

Hoffman, W., R. Albrecht, W. Atchison, S. Charp, A. Forsythe. Computers for school mathematics. The Mathematics Teacher 58:393-401. May.

Ingraham, L. W. 1967. Teachers, computers, and games. Social Education 31:51-53. January.

Janssen, P. A. 1966. Where new technology will take education. Nations Schools 78:70-73. October.

Loughary, J. W. 1967a. Can teachers survive the educational revolution: Phi Delta Kappan 48:204-207. January.

Loughary, J. W. 1967b. Man and machines in education: All systems go? Harper and Row, New York. 242 p.

May, K. O. 1966. Programming and automation. The Mathematics Teacher 54:444-453. May.

Richardson, J. O. 1966. How computers will fit into tomorrow's classrooms. Nations Schools 78:84. October.

Riesdesel, C. A., and M. N. Suydam. 1967. Computer assisted instruction. Arithmetic Teacher 14:24-29. January.

School Management. 1966. What can computers do for you? School Management 10:133-141. September.

Science News Letter. 1961. Teaching by computer. Science News Letter 80:255. October 14.

Silberman, C. 1966. Technology is knocking at the schoolhouse door. Fortune 74:120-125. August.

Stark, J. R. 1967. Educational technology: A communications problem. Phi Delta Kappan 48:194-198. January.

Suppes, P. 1966. Uses of computers in education. Scientific American 215: 206-208. September.

Suppes, P. 1967. Teacher and computer assisted instruction. National Education Association Journal 56:15-17. February.

Swets, J., and W. Feurzeig. 1965. Computer-aided instruction. Science 150:572-576. October 29.

Zinn, K. L. 1966. What computerized instruction is all about. Nations Schools 78:78+. October.

VITA

Dennis C. Jensen

Candidate for the Degree of

Master of Education

Report: An Investigation of Computer Assisted Instruction

Major Field: Elementary School Administration

Biographical Information:

Personal Data: Born at Providence, Utah, October 15, 1934, son of Jesse N. and Lola Checketts Jensen; married Lorna Winborg, April 18, 1956; three children--Deborah, Rebecca, and Denese.

Education: Attended elementary school in Providence, Utah; graduated from South Cache High School, Hyrum, Utah in 1952; received Bachelor of Science Degree from Utah State University, with a major in Elementary Education and minors in English and History, in 1956; completed requirements for the Master of Education Degree in Elementary School Administration at Utah State University in 1967.

Professional Experience: 1958-1960, taught sixth and seventh grades at North Logan Elementary School; 1960-1967 served as Principal of Millville Elementary School; 1967 to present, Principal of Providence Elementary School.