Computer-Assisted Instruction and the Schools

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FOR some years now, teachers at all levels from kindergarten through the university have been reading conflicting statements about the onrushing revolution in the schools to result from the advent of computer-assisted, computer-based, computer-managed, or some other version of computer-regulated instruction.

What are the facts? Is CAI (computer-assisted instruction) firmly rooted in a research base? Has field testing in the real classroom setting tested its effectiveness? Have costs come down sufficiently to induce educators to consider implementation?

The Research Base

Writing in a special issue of *American Education* [1] in 1967, R. Louis Bright, then Associate Commissioner for Research in the U.S. Office of Education, predicted that by 1977 computers would bring about a major revolution in the classroom not unlike the one that had already occurred in industry.

In a somewhat analogous vein, R. W. Gerard, Dean of the Graduate Division of the University of California, said several years later:

> Computers, and computer-aided learning, as an important aspect of their use, are likely to make major changes in society and in man himself.[2]

However, about the same time, Oettinger and Marks [3] in a book entitled *Run, Computer, Run* were extremely pessimistic about the possibilities of the computer for improving the instructional and learning processes of the schools.

Hundreds and even thousands of statements pro and con could be cited pertaining to the feasibility of CAI or some version of it. More important for our purposes here, however, is the actual status of the research.

For the serious student of the field, the first really comprehensive review is Hickey's report in 1968.[4] Here is an accurate and comprehensive review bringing us up to date as of 1968 on applications of CAI, major

[1] R. Louis Bright. "The Time Is Now." *American Education* 3 (10): 12-14; 1967.

[2] R. W. Gerard. "Computers in Mathematics and Other Education." In: *Computer-Assisted Instruction and the Teaching of Mathematics*. University Park: Pennsylvania State University, National Council of Teachers of Mathematics, 1969. p. 13.

[3] A. G. Oettinger and S. Marks. *Run, Computer, Run: The Mythology of Educational Innovation*. Cambridge, Massachusetts: Harvard University Press, 1969.

[4] A. E. Hickey, editor. *Computer-Assisted Instruction: A Survey of the Literature*. Newburyport, Massachusetts: ENTELEK, 1968.

CAI research centers, systems development, programming languages, theories of instruction, and evaluation.

One of the significant findings that has emerged is a sharp reduction in time required to attain mastery *in some circumstances*. For example, Hickey reports a study by Grubb and Sefridge as follows:

> Using CAI, the students in one half of a course on psychological statistics . . . covered the material in 5.3 hours compared with 49 hours for the lecture mode and 12.2 hours for the programmed text. The average achievement score in the CAI mode was 94.3 compared with 58.4 in the lecture mode.[5]

In another study reported by Hickey, Atkinson

> Analyzed weekly-performance records of first graders receiving CAI in initial reading in the Stanford Project. At the end of 1 year he found a difference between the fastest and the slowest student of 6,250 problems completed. The interquartile range was 1,875 problems.[6]

Another of the leaders in research on CAI is C. Victor Bunderson at the University of Texas. Bunderson [7] makes clear that students do learn with carefully developed CAI programs. While not citing research findings in this particular paper, Bunderson goes far beyond this acceptance to deal with such issues as whether these programs should take students step by step through carefully developed sequences or enable the student to use the computer in a discovery manner. His questions concern how, under what learner strategies, and the like, learning can be maximized.

Duncan Hansen, another leader in CAI research, recently reported on developments

[5] R. E. Grubb and Lenore D. Sefridge. "Computer Tutoring in Statistics and Coursewriter." *Computers and Automation*, Vol. 13, No. 3; March 1963.

[6] R. Atkinson. "Computerized Instruction and the Learning Process and Results." Institute for Mathematical Studies in the Social Sciences, Technical Report No. 22, September 1967.

[7] C. Victor Bunderson. "Current Issues in the United States Regarding CAI: Technical Memo No. 3." Austin: University of Texas, Computer-Assisted Instruction Laboratory, 1970. p. 25.

in his center in Technical Report 9, 1970.[8] Included are research studies on the teaching of collegiate physics using CAI, science curriculum for students in grades 7-9, the training of elementary teachers, and much more.

Emphasis in the center includes research on effective instructional processes using CAI, investigation of learner strategies, and the implications of a computer-arranged rather than a computer-assisted approach. His findings include, for example:

> Comparison of the performance of the CAI FLEX group with the performance of 22 subjects taking the conventional physics course showed no significant differences between the groups on final grade achievement or performance on the traditional examination. . . . However, the more striking results suggest that generally speaking persons who are slightly less mature in their academic style, who are more sensitive and esthetic, and who are not scientifically oriented, have a higher probability of success if they take their physics instruction via the CAI/media course.[9]

An army study examined the feasibility of using computer-assisted instruction in the teaching of basic electronics.[10] The course was for two days and involved the use of the IBM 1500 Instructional System using the Coursewriter II Language. Findings indicated (demonstrated) that ". . . CAI can teach basic electronics as well as conventional instruction, and in less time."

Along the line of a computer-based instructional management system is the work of Richard E. Sass at the University of Pittsburgh.[11] Sass concluded, overall, that his instructional management program, implemented in an elementary school in an individualized setting, was successful in that the children learned their first grade science; but that, as yet, factors such as cost, computer reliability, and immaturity of very young children indicate it is not practical at this time.

A Look Ahead

Only a few of the thousands of studies in the literature have been cited here. Hopefully, however, enough has been said to demonstrate that, at the least, CAI is very much with us in a research vein. Yet what of the future? Can educators begin to make plans for implementing CAI programs? Or should educators beware at this time?

Hansen investigated a facet of what might come in a recent research project.[12] Based largely on his own research and the research of his doctoral students in CAI, Hansen ventures a number of predictions about changes in *teacher role*. More specifically, he ventures ". . . teachers will perform much less of the informational presentation functions . . . have a greater involvement in guiding individual students rather than maintaining classroom discipline . . . play less of the corrective role . . . become more concerned with individual characteristics . . . have a wider range of discussion techniques . . ." and overall will be capable of enabling a far higher degree of individualized instruction than at present. These indeed are encouraging words, since they are uttered by a person deeply involved in the research. Yet how about implementation at this time?

There is no question but that the rudiments of CAI are now successfully operating

[8] Duncan N. Hansen, Harold F. O'Neil, Bobby R. Brown, Arthur D. King, and LeRoy C. Rivers. "CAI Center Technical Report 9." Tallahassee: Florida State University, Computer-Assisted Instruction Center, February 1970.

[9] Duncan N. Hansen, Walter Dick, and Henry T. Lippert. "Research and Implementation of Collegiate Instruction of Physics via Computer Assisted Instruction." Tallahassee: Florida State University, Computer-Assisted Instruction Center, Vol. 1; November 15, 1968. p. 131.

[10] Alexander A. Longo and Vincent P. Cieri. "The Feasibility of Computer-Assisted Instruction in U.S. Army Basic Electronics Training." Quoted from: American Educational Research Association. *Paper Abstracts*. Washington, D.C.: the Association, 1969. p. 33.

[11] Richard E. Sass. "A Computer-Based Instructional Management Program for Classroom Use." Pittsburgh, Pennsylvania: Learning Research and Development Center, University of Pittsburgh, 1971. p. 13.

[12] Duncan N. Hansen and William L. Harvey. "Impact of CAI on Classroom Teachers." Technical Memo No. 10. Tallahassee: Florida State University, Computer-Assisted Instruction Center, 1969.

in thousands of high schools and some junior high schools in the form of a time-sharing terminal. These typewriter-like devices are typically located near the science and mathematics laboratories of high schools, usually in urban centers, and are hooked to a central computer. Using these, students are learning to write small programs in BASIC or FORTRAN or some other computer language. They are playing simple games on these devices, and they are modifying some of these games to suit their own interests. They are using the computer in a modified interactive sense.

The success of these devices is beyond question. Students are "turned on" by them, do learn from them, and become extremely creative in their use. Too, the expense of renting such a terminal is not very high and is decreasing year by year. Yet these are not CAI in the sense used in much of the literature, that is, the taking of lessons at the terminal.

It is true that some companies have begun to market programs in spelling, arithmetic, and the like. At this time, however, most of these require expensive computer time, expensive telephone time and, in addition, are not adequately researched as to their total cost and effectiveness. Add in the current unreliability of the computer itself and the picture is as yet not good.

Another factor that plagues us is the seeming immunity of colleges of education to developing curricula in computer science and computer applications to education.[13] It is doubtful that intelligent decisions by our curriculum coordinators, principals, and superintendents will be made in this area until there are professional educators who are informed of the strengths, limitations, and possible applications of computers in relation to the educational processes. This knowledge should include at least a rudimentary grasp of at least one computer language, some

[13] Gary D. Brooks. "Computer Science: A Neglected Area in Schools of Education." *Phi Delta Kappan* 53 (2): 121-22; October 1971.

examination of the learning theory behind the approaches being used, and some work in curriculum design.

Perhaps one of the most exciting avenues of development lies in the applications of the computer to *managed* instruction. It is here that some phases of truly individualized instruction will emerge. In computer-managed instruction the actual student learning uses texts, films, tapes, etc., but the monitoring of the student's program, suggestions as to what to begin next, diagnosis, and the like, take place without continual and expensive involvement with the computer itself.

The history of virtually all technological developments has been that in the early stages the devices are (a) costly and (b) unreliable. Both of these factors characterize CAI today. In addition, man has not learned how to use it effectively. Much of the research on effective usage is still out.

Yet the technology, the hardware, is here. It is not unreasonable to venture that in a few short years part of each child's day will be spent in interaction with a computer-assisted or computer-arranged instructional program. Some of this will be via telephone for the shut-in or the student needing extra drill on skills while at home or during the summers. Some will take place in a guidance context. Much will initially be of a basic-skills drill nature; but the highly sophisticated, inductive type, open-ended inquiry mode enabling a high degree of divergent thinking is on the way.

It behooves us as professional educators to become more aware of what is happening; to encourage the modification of our teacher training programs to incorporate elements of this field; in short, to get ourselves in a position to make reasonably intelligent decisions in this area—as we will be called upon increasingly to do.

The computer is here to stay. While it is presently largely performing functions such as payroll processing and scheduling, it will increasingly be having an impact on the learning process. In a few years it will affect virtually every student from the kindergarten through the graduate school in some way or another relating to his learning.

Note: As this review goes to press, the reader should know that two major efforts to demonstrate the efficacy of CAI are under way: (a) PLATO (programmed logic for automatic teaching operations) by the University of Illinois, under the direction of Don Bitzer; and (b) Ticcit (time-shared interactive-computer-controlled information television) by the University of Texas and Brigham Young University, under the direction of Kenneth Stetten of Mitre Corporation.

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