Using Computers in Education: Some Problems and Solutions

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Abstract: An instructional management system is described as an interim step to computer-assisted instruction. The rationale for the instructional management system stems from the consideration of several problems in using computers in education; problems of system development, cost, communication, system integration, and user acceptance are considered.

Almost every day we hear about the great benefits to be derived from the use of computers in education. Instant access to distant libraries, individualized instruction, and relief from the many clerical chores associated with school administration are among the advantages frequently listed. These are reasonable objectives, but the problems involved in realizing them are often ignored. This paper discusses a few of the questions frequently asked about the use of computers in education.1

The first question is: “How does one go about designing a computerized instructional system?” One approach is to concentrate on what one is trying to accomplish in the particular instructional system, and adopting a cut-and-try procedure to achieve the desired goals. This procedure can be illustrated by a brief description of our work at System Development Corporation.

In an attempt to design improved instructional materials, we have conducted a fairly extensive series of experimental comparisons. The most notable result of these comparisons was that only marginal statistical differences among experimental treatments were obtained. Different sequencing procedures, cueing techniques, and confirmation procedures had but limited practical effect on student learning.

One procedure we tried, however, was successful. This consisted of a careful specification of learning objectives in behavioral form, followed by a succession of evaluation-revision cycles. As each defect in the instructional material was detected, the behavioral components involved were reanalyzed and specific changes were made to the defective segment. Ideas for possible changes were obtained from interviews and individual tutorial sessions with students. Gaps were filled, irrelevancies eliminated, and frames modified. Re-
peated evaluation-revision cycles were conducted until new students exposed to the materials consistently achieved a given set of absolute objectives.

This process is quite different from a one-time comparison of the first version of a new package with so-called "conventional" procedures. It is more like the cut-and-fit engineering process, where the development activity is followed all the way through the final stage of implementation. It is an extremely costly process, since building a product to specifications can be an endless task. Rather than a single evaluation to decide whether or not to adopt a new set of materials, the engineering approach implies a commitment to make the new material work, since most things fail on the first try anyway. The traditional comparative study, on the other hand, seldom goes further than a research report and has little impact on classroom practice.

Persistent use of the evaluation-revision cycle will eventually produce quality materials that work—but this does not completely solve the problem of designing an effective instructional system. Even if large quantities of self-instructional material of high quality were available, many difficult implementation problems would remain. For example, if students move through the instruction at their own rate, how will it be possible to keep track of them? How is it possible to detect those who are not performing correctly and to diagnose the source of their trouble?

One of the greatest deterrents to individualized programs is the difficulty of managing the instruction—it is far easier to keep everyone in lockstep groups, even at the expense of optimal learning. The resistance to individualized instruction may not stem from conservatism as much as from the management problems associated with the newer techniques. The inefficiencies in classroom management can be so gross that the beneficial effect of finely polished instructional material may be relegated to the noise level. A smaller class group is not the whole answer: Even ratios of 15:1 do not permit detailed monitoring of individual student performance. How is the teacher to decide who receives help, what materials to change, or how much review is required if he lacks the data on which to make such decisions? The usual decision is made by giving help to the most vocal student—who may need it least! Some kind of management system is required to monitor student performance.

The second question, then, is: "What kind of management system should be established?" An instructional management system requires some means of collecting performance data from the student, some means of analyzing the data, and some method of displaying the result to the teacher. Manual procedures would only add to the teacher’s already excessive clerical burden, so let us assume that a computer is available for this task. A host of subsidiary questions is immediately raised by the introduction of a computer into the instructional management system.

One example is my third question: "How will school personnel and students, untrained in the field of computing, communicate with the machine?" One reason why some school personnel reject systems involving com-
puters is that they cannot control the operation; they can only direct the machine through an intermediary programmer. The programmer, not unnaturally, builds a system for his own convenience, and once it is built he is reluctant to make major changes in it. The user soon recognizes the rigidity of the system that was supposed to serve him, and either relinquishes his responsibility to the programmer or bypasses the machine system with an informal manual system of his own.

At SDC we have recently developed a user-oriented computer language that allows a nonprogrammer author to prepare a lesson on a computer for subsequent presentation to a student. This language, called PLANIT, interprets for the computer the lesson design that is typed by the content expert (the teacher) in his own natural English. For example, PLANIT will begin operating by typing a message to the author asking him to choose one of several kinds of lesson frames. The author types the letter indicating his choice, and PLANIT then requests the text of the frame. The author types a text or a question. PLANIT asks for anticipated answers and the author types expected responses. PLANIT next asks the author what actions should be taken, depending on the particular answer given by the student, and the author types feedback messages and appropriate branching decisions for various answer possibilities.

When the lesson is ready to be executed, the student types “GO” and receives the instructional items in the designated sequence. A special feature of this language is that it allows the student to ask as well as answer questions in his natural (occasionally ungrammatical and misspelled) English. This question-answering capability is a new development that promises to add greatly to the effectiveness of computerized instruction. The main advantage of a user-oriented language like PLANIT is that it enables the nonprogrammer author to communicate directly with the machine by merely sitting at a typewriter keyboard and writing the instructional sequence.

The fourth question raised by the introduction of a computer into the instructional management system is: "How can a school afford the cost?" Anyone seriously considering the installation of a computerized instruction system need only calculate the rental charges of the computer, the cost per student terminal, and the transmission charges...
line charges (not to mention the backup costs of personnel who tend the needs of the system for new materials, and maintenance services), to be convinced that a sober reappraisal of the budget is in order prior to such innovation. There have been estimates that the cost of one console hour of instruction per student is eighty cents to one dollar, but it is doubtful that such rates include all the hidden costs involved. The cost problem, salesman arithmetic to the contrary notwithstanding, is an important deterrent to the widespread implementation of computerized instruction.

Several alternatives that promise to alleviate the cost problem are available. Present hardware developments indicate that great reduction in cost will be achieved in a few years. In addition, the new technique of computer time-sharing promises to reduce the cost per student. Prior to time-sharing, the machine spent most of its time waiting for a new response from the user. With time-sharing, each of the various programs associated with different users is shuttled in and out of storage, operated in a fraction of a second, and replaced by another. In this fashion, better computer utilization is achieved and costs of computer time are shared, yet each user appears to have direct and instant access to the entire machine for himself.

Another method of reducing the cost of an instructional management system is to downgrade the system to some less costly compromise configuration. For instance, instead of providing an input terminal for each student, the system might employ a smaller number of terminals to be shared among stu-

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dents who are scheduled (by the computer) to use the terminal at different times during the day.

Still another method is to use a simple button-box input with small feedback lights instead of the more elaborate “rich” terminal with its TV tube, keyboard, random-access film, sound, etc. In an even cheaper configuration, the “rich” terminal is reserved for the sole use of the teacher in querying the record of student performance. The student responses are entered in printed booklets treated with a material that changes color when the page is marked in the correct fashion, providing the student with immediate knowledge of results. The pages are sent to a central office each day where they are read by a test-scoring machine that puts the data on magnetic tape. The tape is read by the computer, and the data are analyzed and sent back to the school over telephone lines to generate special displays (at the single “rich” terminal) indicating to the teachers which students are having difficulties, what kinds of problems they are having, and what materials may be helpful to them. This alternative saves the high cost of a terminal for each student, but it requires optical scanning equipment to read the data from the students’ booklets.

Although the problem of alleviating the cost of the physical configuration seems manageable, little optimism is warranted for the solution of the backup logistics problem, which lies waiting like a submerged iceberg. To maintain the reliability of the physical system, to develop new computer programs and instructional material, and to continually evaluate and revise the system, there must be a staff of well-trained specialists whose ongoing price far exceeds the already substantial outlay required merely to install the system. Too often, school boards ignore the ongoing backup cost, buy the tangible physical system, and later wonder why it is not used. The fact that the necessary services may be supplied by the manufacturer does not alter the cost; it merely moves it to a different budget category.

The difficult part of the cost problem is that we have not translated our subjective valuation of student learning into dollar terms. Thus, by default, the economic analysis is reduced to the principle of maintaining the existing budget level. This principle requires that the innovation of a computer system be justified not by its instructional value, but by its elimination or reduc-
tion of some other budget category, like teachers' salaries. Even the backup costs and the lack of cost/effectiveness criteria, however, may be alleviated somewhat by integrating instructional management with other school functions such as counseling and administration that may also benefit from the system and be able to share its cost.

I am convinced that if a tool really is useful, it will eventually be accepted in education. General-purpose tools introduced in one school will be carried to another by people trained to use them. Others will carry the technology to the next school, and so on. The installation of equipment per se confronts school people with a tangible problem of adjustment, almost forcing change by its very presence. Much of the concern about political obstacles to innovation may in fact merely reflect a healthy resistance to tools that either do not work or are more time-consuming than they are useful.

A final point which should be made is this: As instructional management systems are developed and used, data will be available to justify the need for school reorganization to allow for individualized instruction. Such reorganization will, in turn, lay the foundation for computer-assisted instruction on a wide scale. Extensive use of computers, however, is still a number of years away, despite the present CAI experiments that receive so much publicity.

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