

PERHAPS no innovation in recent history has caused so much furor, has captured so much interest, has been so grossly maligned and, at the same time, has resulted in such critical analysis of the teaching-learning process as has the teaching machine—or more correctly, programmed instruction. Growing from the laboratory manipulation of subhuman organisms by experimental psychologists, the teaching machine has been cited either as the answer to most of our educational problems or as the next step in the increasing pace of dehumanizing our educational system.

Few educators are unaware of the basic principles of programmed instruction. Virtually every professional convention has had sessions devoted to the topic; most professional publications have included articles describing programmed instruction; increasing attention is being given to the reports of research using programmed instruction; most major publishing companies have marketed programmed textbooks, and major corporations (IBM, DuPont, Xerox, U.S. Industries) have made substantial, long range investments in the development of programmed materials and devices.

This article will not attempt to describe either the basic theoretical formulations or the practical applications of programmed instruction. The interested reader is referred to any one of several new books in the field (1, 2, 3). A note of caution, however. Publications more than two or three years old are badly outdated and have little more than historical value. The early pronouncements, "basic" principles, and recommendations of many self-styled

**WILL
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authorities in the field have been reversed if not at least challenged by subsequent research and application in the past year or two.

Unfortunately, many skeptics are still basing their positions concerning programmed instruction on information which is no longer accepted by knowledgeable people or on the basis of their experience with some of the first available programs or machines. The field is in a very dynamic state. There is a real danger that premature closure on programming styles and machine design will seriously hinder the ultimate development of programmed instruction.

One of the most amazing aspects of the movement has been its rapidity of development and implementation. While Skinner's article in *Science* in 1958 (5) is regarded as the first serious proposal for utilizing teaching machines, it was not until the early 1960's that programs and machines became generally available.

In just a few short years, a promising and possibly threatening innovation has burst upon the educational scene and has influenced students, teachers, curriculum planners, textbook publishers, building designers, as well as large segments of the general public. Even more dramatic has been the widespread and enthusiastic acceptance of programmed instruction by business and industrial educators. One of the most encouraging aspects of programmed instruction has been its ability to overcome the barriers that educators so often raise when dramatic innovations are proposed.

It should also be noted that the pace of acceptance by educators has been distressingly slow from the perspective of many proponents of programmed instruction as well as publishers of programmed materials. Professional journals have had an increasing number of

articles in which educators are criticized for their reluctance to embrace programmed instruction.

The point is this—programmed instruction has been accepted by educators far more rapidly than any other innovation in history.

Does It Work?

Does programmed instruction work? Do students learn when using programmed textbooks or teaching machines? The most clear-cut answer has come from Schramm in his excellent summary, *Research On Programmed Instruction* (4), in which he reviews hundreds of research studies. His conclusion is very simple. Programmed instruction can be effective in helping most students achieve specified behavioral objectives, in a variety of subject areas, and using a variety of programming techniques and presentation devices. The key phrase is "specified behavioral objectives." The crucial task is to specify what we want the student to learn, and the behavioral criteria he must meet to demonstrate his learning. If the behavioral objectives can be specified, there seems to be little argument that a carefully constructed program will help most students attain the objectives.

While much of the research evidence may appear to be contradictory to the casual reader, the contradictions arise from the question "Which method of programmed instruction is most effective and/or efficient?" Linear-branching? Small step-large step? Overt response-covert response? Textbook-machine? Inductive-deductive? These are the research questions that are receiving attention today. As the head of

a large corporation recently declared, "We know programmed instruction works. Now we're trying to find the most effective way to use it."

Unfortunately, many educators are still demanding research which compares the results of programmed instruction with the results of "conventional instruction." Schramm cites some 36 studies which have been attempted. Such efforts are no longer necessary and are probably misguided from a research point of view. While it is essential for the programmer to specify the prerequisites, the sequence, the style and the outcome of his learning experience, it is virtually impossible to specify and control these characteristics in a conventional classroom setting to the extent which would permit valid generalization to larger populations. Our efforts should be expended in defining our instructional objectives and then searching for the most effective and efficient ways to help students attain those objectives.

Is efficiency a "dirty word" in education? Many persons would say it is and object strenuously to the demonstrated capability of programmed instruction to increase the efficiency in terms of time and energy expenditure of students in achieving stated objectives. They decry attempts to force more and more "content" (another questionable word) upon students and the seemingly ominous pressure to do more things faster.

Rather than bow to such critics, we should be asking the question, "Are we doing all we can to help the student make efficient use of his time and energy?" We should be stripping the non-essentials from our courses, eliminating needless drill and repetition, providing

alternate opportunities for fast or slow learners, and constantly challenging all students to set and achieve new objectives. All of these can be accomplished by carefully developed programs but are very difficult to achieve in conventional instructional settings.

Even the casual observer of the typical classroom must agree that many students do not make efficient use of time and energy. While one may argue that this makes school more enjoyable for some, it is also quite likely to be a cause of the obvious disenchantment of many students with their school experiences.

Student Reaction

The most disturbing evidence on the use of programmed instruction concerns student reaction to the technique. The early reports of overwhelmingly enthusiastic reactions to programmed instruction have been contradicted by increasing numbers of neutral and negative reactions. Reports of "dull," "boring," "repetitious," and "uninteresting" have come to be expected. (Of course, we would get the same reactions from many students concerning any instructional technique.) However, the author has studied the reactions of thousands of students and has found a substantial majority who express generally positive reactions. In one study it was obvious that student reaction was not a function of the program used or of the experimental treatment but more likely a reflection of the classroom teacher's attitudes.

It is becoming increasingly clear that the technique itself is no panacea for the pervasive problem of motivating the student to want to learn. Skinner's

earlier position that the reinforcement received by making correct responses would be sufficient to sustain motivation must now be discarded in the light of the evidence. The problem is to find a program that is within the subject area interest of the student, has a step-size and programming style that is challenging to the student, and then to use the program in a supportive situation. This suggests the need for a wide variety of programs on any given topic to match the unique characteristics of individual students and the preferences of their teachers.

Teacher Reaction

There is no question that the large majority of educators are, for real or imagined reasons, less than enthusiastic about programmed instruction. On the other hand, the overwhelming majority of teachers who *try* programmed instruction are generally enthusiastic. The author has worked with hundreds of classroom teachers who have used programmed instruction. In almost every instance, they expressed positive reactions to the *technique*, although not always to the particular program or the way in which it was used.

One of the most often cited reactions is that programmed instruction enables the teacher to have *more* time to work with individuals and small groups. Relieved of the time-consuming tasks of presenting information, monitoring student activity, and checking students' work, the teacher is able to devote his time to the far more challenging—and professional—tasks of clarifying, analyzing, synthesizing and generalizing from the basic content presented by the program. Thus, contrary to the charges

of many critics, programmed instruction can actually increase opportunities for interpersonal contacts among teachers and students.

The Future?

The future directions and use of programmed instruction are inexorably bound to the development of another looming technological colossus—the computer. Programmed instruction as we know it today in the form of programmed texts or simple mechanical type machines will probably continue to be used in school and other educational settings for the next several years. Even in this primitive form it will continue to demonstrate the feasibility of shaping intellectual behavior in the direction of specified objectives.

In the not too distant future, however, use of the programmed text will be restricted to highly individualized instructional settings. Programmed instruction will have turned to the computer for assistance in overcoming some of its present limitations.

Some advantages of computer-assisted instruction are these:

1. The computer enables the programmer to utilize branching techniques far more effectively than a programmed text.
2. The storage capacity of the computer enables the programmer to provide "feedback" for a virtually unlimited number of responses.
3. The computer can adapt the sequence and rate of presentation of material as a function of student characteristics or performance.
4. The computer can coordinate the use of audio, visual and kinesthetic stimulus and response modes to supplement the verbal mode.

These and other capabilities of computer-assisted instruction (CAI) are being demonstrated and developed in a number of settings throughout the country. The "hardware" will be generally available within 3-5 years. While substantial costs will be a deterrent in the near future, it is likely that CAI will be economically and logistically feasible within the coming decade.

So what is programmed instruction—just another fad—another bandwagon in the educational circus parade? Not at all. Programmed instruction as we know it today represents the earliest phase of a systematic analysis of the teaching-learning process. For one of the first times in educational history, an idea has captured the imagination of psychologists, engineers, technicians, architects, businessmen, publishers—and educators.

The idea can be stated most simply: decide what is to be taught, determine the terminal criteria, and systematically explore the most effective and efficient means of helping the student meet the criteria. The "means" might be a small-step, carefully sequenced series of frames or it might be a film clip, an audio tape, a series of slides, a lecture, a group discussion, or a tutorial session.

The "systems" approach to educational planning requires the precise analysis of the unique characteristics and capabilities of a variety of learning

activities which can be used to attain objectives. The approach is based on the deceptively simple but obviously neglected assumption that some learning techniques are more effective for some learning outcomes than others.

In summary, programmed instruction has made a dramatic impact on educational practice in a relatively brief time. There is strong evidence that programmed instruction works although there is considerable disagreement over the most effective techniques.

Perhaps the most significant contribution which programmed instruction will make is dramatizing the necessity of systematic analysis of the teaching-learning process and the determination of the most effective means of instruction for various subject areas as well as various students.

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