Teaching Machines

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Except for the catalysis brought about in the fifteenth century by the printing press, evolutions of science have sidestepped most aspects of classroom teaching. But a mutation has now appeared in educational methodology: the development of automated instructional devices—teaching machines. Optimistically, scores of new industries, publications, training programs, and research projects have been launched in the wake of this development.

Threatened by an onslaught of new paraphernalia, many educators are bewildered and justifiably concerned. "What are teaching machines?" they wonder. "How did they come about, and what are their strengths and limitations? Will they prove to be as disappointing as educational radio? Are they likely to make obsolete many traditional classroom procedures?" These general questions will be considered first and then some predictions will be made about the role of teaching machines in the schools of tomorrow. Readers interested in specific, current developments will find a comprehensive survey of teaching machines in Morrill (1) and a review of programming techniques in Rigney and Fry (2).

WHAT ARE TEACHING MACHINES?

The advanced degree to which teaching machines actually provide two-way communication distinguishes them from other instructional media, e.g., reading pacers, film projectors, and television. To be sure, teaching machines, in themselves, do not teach. But just as a pilotless drone flies by reacting to atmospheric pressures, a teaching machine teaches through its reactions to the responses of the pupil.

Atronic Tag, Autoscore, Koncept-O-Graph, Min/Max, and Videosonic are some of the current models of teaching machines being sold. A few salient characteristics are common to all. The curricular material is presented in orderly, minute, step-by-step sequences or frames. The pupil must actively participate by making either multiple-choice, write-in, and/or verbal responses. He responds by pulling a lever, pushing a button, or tripping a relay with his voice. All teaching machines feed back information about the correctness of each response immediately after the pupil makes it. The sequenced or programmed material may be presented on belts, microfilm, paper, sheets, or tapes.

Within the past year there has been an upsurge in attempts to design formats suitable for the self-instruction of material without a machine. These efforts have been described as "programmed learning." The same attributes obtain; the learner uses a programmed textbook instead of a machine. Developments in programmed texts are likely to eliminate many marginally useful teaching machines. The texts offer considerable economical and practical advantages; any teaching machine that can be displaced by a programmed text ought to be discontinued.

STRENGTHS

The excitement over teaching machines stems from the possibility of their improving learning efficiency. Socrates asserted that the key to knowledge is constant questioning and answering, and Descartes believed that complex knowledge must be built upon clear, fundamental ideas. Contemporary learning theorists have long been aware that the most effective learning occurs where each pupil is carefully guided in making appropriate responses, where his expectations are confirmed, and where he actively participates in the learning endeavor. But these venerable notions are difficult to implement in terms of individual differences in rate of learning when teachers must work with 20-40 pupils simultaneously. Limitations in the size of classes diminish, however, when machines that will simulate some of the teacher's functions are added to the classroom. Given factual or conceptual materials analyzable into discrete units, teaching machines can guide, control feedback, and make the pupil's progress in learning contingent to some extent upon his undivided attention.

Teaching by machine offers several other advantages. Machines that "patiently wait" for the learner to decide upon each of his answers allow him to deliberate unhurriedly. Because each answer is immediately confirmed or rejected, he is fully aware of his progress. Contrast a classroom learning setting where every pupil establishes his own pace and is knowledgeable of his progress with the conventional television techniques that assume uncritically that every pupil, irrespective of readiness and proficiency, listens attentively and learns at the same uniform rate. Imagine a classroom where pupils may proceed slowly, free from tension caused by falling behind, or where pupils may proceed rapidly, assured that their speed is not causing them to miss half the essential content. Furthermore, to the extent that a machine assumes certain tasks of the teacher, the latter is freed for planning lessons or teaching other pupils on an individual basis.

These advantages have led to several claims, most of which are yet to be substantiated. It has been said that machines will replace the teacher in the classroom, and that pupils can learn twice as much in half the time with half the effort. It has even been suggested that widespread use of teaching machines in Africa might solve the illiteracy problems of that continent! A few individuals are so charmed by the potential of teaching machines that they think people in front of a machine will be helplessly docile and thus can be indoctrinated against their will.

LIMITATIONS

Alongside missiles and rockets, most contemporary teaching machines are mere mechanical toys. Compared to other wonders of modern technology, current models of teaching machines seem products of the Bronze Age. Many machines fatigue the pupil easily because their mechanical operation is slow and clumsy, and because they must be operated from an awkward posture. In some models, the crumpling and tearing of programs is commonplace, and, frequently, cheaply constructed gears slip or bend.

Until smoothly working machines are widely available, optimum operating periods will be difficult to assess. Although claims have been made that machines increase motivation to learn, novelty may account for most of the increment. After repeated exposure, any motivation aroused by the novel properties of the machine itself should disappear. The chances are that, unless technical improvements occur, pupil interest will diminish to the point of no return. Hughs Aircraft Company (3) has developed an aural-visual device, named the Videosonic, which is indicative of the type of teaching machine that may obviate the difficulties inherent in other current models. The Videosonic machine projects photographs accompanied by coordinated voice instruction. The pupil responds by pressing one of several buttons. A discussion of his answer is presented via earphones from an automatically controlled, slow-speed magnetic tape. The Videosonic, besides overcoming many of the shortcomings of the more hastily designed teaching machines, offers both visual and audio modes of pupil-machine communication and thereby gains greatly in flexibility.

The lack of standardization is an additional problem. A great many teaching machines are commercially available and hundreds of programs are being written. But few programs written for one machine can be used in another. Programmed curricula for teaching machines are expensive. A year's course in physics, comprising 16,000 frames, may cost from $25,000 to $50,000 to write, test, and market (4). Until a degree of standardization is attained, costly efforts will be duplicated, and individuals and schools will be limited to using the few programs that can be accommodated in the machines which they happen to own. However, set against the need for standardization is the possibility that the widespread use of standarized programs might create a national conformity of educational aims and practices, which in itself might be undesirable.

As indispensable as teaching machines may become, they will never replace human teachers. Only a knowledgeable individual can decide whether something is worthwhile learning, i.e., whether it will be useful to the learner later in life. And, since some learning inhibits later learning, it is doubly important that the teacher's professional judgment be used in selecting curricula.

Furthermore, factual learning, which comprises the content of most programs, is only a means to the more important cognitive processes associated with intuitive, judgmental, and problem-solving behavior. Eventually, machines must demonstrate that they facilitate the learning of these processes. Even if it should be shown that one teaching machine program facilitates acquisition of factual content better than another, there remains the primary question: What effect will the learning have on higher level cognitive processes? Although many programs have been commended to teachers, the best sequence of the subject matter, the most effective kind of cues or hints, and the nature of responses that should be elicited remain unsettled issues. Eventually research may provide realistic guidelines, but conceptual learning by machines can never be complete. Apart from the obvious limitation that concepts, which by definition are abstractions, are never completely learned, there are

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