EDUCATION

Machines for Teaching

Teaching machines based on step-by-step education and immediate reward for correct response are being used to spur the learning process, Judy Viorst reports.

➤ AN APPLE for the teacher is being replaced by a can of oil for the teaching machine in classrooms all over the country.

Machines based on the principle of reward for correct response are teaching everything from spelling to matrix algebra. And psychologists are experimenting with very simple machines to teach retarded children and elicit responses from schizophrenics.

Drs. James G. Holland and B. Frederic Skinner, psychologists at Harvard University, have been working for a year with retarded children. They use simple teaching machines to build up pattern recognition in 12-year-old boys with I.Q.'s of 50.

Drs. Holland and Skinner have not yet formed any conclusions as to the effectiveness of teaching machines over teachers in the education of these children. But they have found that the machines keep them active and interested in the learning process for long periods of time.

Schizophrenic Children Taught

At the University of Indiana Medical School Dr. Charles Ferster uses a roomful of automatic devices to create a rewarding atmosphere for schizophrenic children. Vending machines produce candy or a sandwich with a push of a button. Another device, when pressed, starts a toy train running. Slowly the children are beginning to understand that a simple reaction on their part will immediately produce a satisfying result.

This prompt reward for the right answer is the key element in the programmed teaching method developed by Dr. Skinner, who introduced teaching machines to education in 1954.

Having taught pigeons to play table tennis by a step-by-small-step technique and a prompt feeding of corn for every move in the right direction, he next applied these methods to human learning. The result: A programmed education system that he believes can teach many subjects in half the time required by conventional classroom procedures.

Here is how the Skinner method works: A year's mathematics course, for example, is broken down into individual items of information, carefully graduated so that there are no big jumps from point to point. Each item, printed on a "frame," ends with a question or an incomplete sentence. The student answers the question and is immediately given a reward—the knowledge that he has responded correctly.

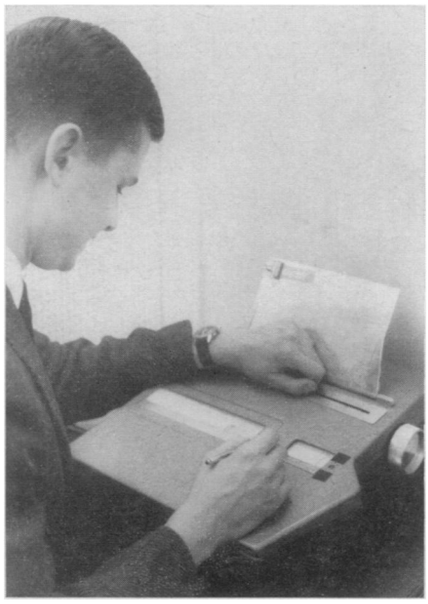
Dr. Skinner's program aims for no more than five percent wrong responses. He is interested primarily in the "reward" aspect of the reward-and-punishment approach to teaching.

Skinner-programmed machines may vary somewhat in appearance, but basically they have the same characteristics. The machine itself is about the size of a typewriter. It has a window in which the frames appear, one by one. There is a place for the student to write his response and a lever to pull to ascertain whether he is right.

The student's answer slides under glass when the machine's answer appears, so there is no chance to change the response. Sometimes a wrong response will call forth a hint from the machine, such as the first letter of the word desired, and the student can give it another try. Then he pulls a lever, the next frame appears and the procedure is repeated.

Essential to an effective teaching machine is a well developed program. The ideal programmer should combine an expert knowledge of a subject with an understanding of teaching machine program technique. But Dr. Skinner believes that an expert in the subject matter working with a programmer can develop sound programs in most fields.

Although programmers do not prepare their programs from textbooks, books based on teaching-machine programs have been published. Doubleday's Tutor Texts use a programmed approach to teaching. But their author, psychologist Norman A. Crowder of U. S. Industries, Inc., differs in important respects with the Skinner method.



LEARNING BY MACHINE—A student using a Skinner-programmed machine is comparing his answer with a hint of the right answer, given by the machine.

Mr. Crowder teaches in larger steps than Dr. Skinner does, offering several paragraphs of information before he ends with a question. He also permits a much larger margin of error, by giving the student a choice of answers.

Dr. Skinner feels that incorrect alternatives to questions impede the learning process, but Mr. Crowder uses them to elaborate on and clarify the original information. Then he sends the student back to select the correct answer, which in turn leads him to another set of facts, a question and multiple choice answers.

Foreign Language Machines

Machines teaching foreign languages have been in use for several years. Basically, these consist of earphones and a tape recording. The student repeats words or phrases, then plays back the tape to compare his responses with the correct ones.

In the future, it is believed, language machines could function like teaching machines—pausing at each response to signal whether it is right, and immediately correcting errors. An entire language course might be programmed in small stages on the machine.

Teaching machine principles could be adapted to film for use before an entire class. This would be particularly helpful in underdeveloped countries. The American Institute for Research, Pittsburgh, Pa., is presenting such a plan to the International Cooperation Administration.

Two questions are frequently asked about teaching machines: How well do machine-taught students retain what they have learned? And—what is going to happen to the teachers?

Few studies have yet been completed on how much students retain when taught by machines. But a check on eighth-graders taking a programmed course in a Roanoke, Va., junior high school has turned up striking results.

The class completed a year of ninth-grade algebra in one semester. Then, after being away from the subject for several months, the students were given an examination. Their scores showed an average retention of more than 90% of the material.

As for the teachers: A few months ago a group of Chicago principals expressed concern that machine-taught students might become push-button unimaginative humans, able to learn and understand only one side of a question.

Other educators warned that teaching machines, by becoming a substitute for human contact, might do harm rather than good.

But advocates of programmed education

consider the machines a teaching aid—not a teacher substitute. Debate, discussion and experiment, they declare, must always remain in the teacher's domain.

The Chicago Schools Journal recently urged teachers to accept the machines. In an article called "Let's Not Say No to the Teaching Machine," it reminded teachers that many of the duties they now have to perform should rightfully be done by mechanical means.

When machines take over these tasks, said the journal, teachers will be free to bring young minds to new heights of discriminating thinking.

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GENERAL SCIENCE

Teacher Attitude Counts

➤ THE ATTITUDE of a teacher, not the subject matter he teaches, is the crucial ingredient of his influence on the development of his science-prone students, it is reported in a study of men and women who competed in the Science Talent Search almost 20 years ago.

The research scientists in the group reported that teachers who were important catalysts in their careers taught them the "probing approach" and encouraged creativity, or offered them special opportunity through extra hours in the laboratory.

Scientists engaged in industrial management received the most direct stimulation from teachers who used a "hard facts" approach to learning.

These and other findings, summarized in the recently released publication "Science Talent, Its Early Identification and Continuing Development" by Dr. Harold A. Edgerton, are based on the study of 1,550 men and women selected from the 6,656 who participated in the Science Talent Search for the Westinghouse Science Scholarships and Awards conducted by SCIENCE SERVICE in 1942 and 1943. All were high school seniors when they competed in the Search, and the sample group included both winners and non-winners of honors in the competition.

Under a grant from the National Science Foundation, the SCIENCE SERVICE study was made under the direction of Dr. Edgerton who has been associated with the Search since its inception, developing the screening procedures and selection techniques.

Some of the other findings reported include:

Those who scored highest on the science aptitude examination were most likely to achieve higher degrees in college.

Those who remained in science came, on the average, from larger high schools than those who changed direction, entering non-science fields.

The physicians in the study group ranked family influence highest among the factors that led to their choice of profession.

The college professors reported that the influence of their older brothers, or friends of their older brothers, was stronger than that of their parents.

The women who were interviewed said their schools and teachers became important as early as second, third and fourth grades.

None of those who had been selected as Science Talent Search winners had changed his early choice of science as a profession, although some changed specific areas of science as their education progressed.

New questions which Dr. Edgerton said were opened up by the survey include how many science-directed high school students actually enter their chosen fields; what becomes of those who do not; what significant influences and obstacles are encountered by women in choosing, training for and advancing in scientific careers; and what clues to degrees of creativity may be discovered in special physical, psychological or personality types, or in characteristic behavior.

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U. S. Press Science Writers

➤ APPROXIMATELY a quarter of the more than 1,500 daily and Sunday newspapers in the United States have a reporter, full or part time, who gives special attention to science, medicine and technology.

This has been revealed in a survey by SCIENCE SERVICE conducted in anticipation of a Conference on the Role of Schools of Journalism in the Professional Training of Science Writers held in Washington, D. C., June 9 and 10.

Almost half of the science writers spend half or more of their time writing science, medicine and technology. More than one-fifth of the daily newspaper science writers spend all their time on science and related fields.

Detailed questionnaires were obtained from 249 daily newspaper and press association science writers.

Most of the science writers have had some science background either in high school or college or both. About 80% had three or more high school science courses, while more than half of these writers had one or more science courses in college.

The greatest number of science writers, 57%, write in the physical sciences while 49% write in the medical sciences. Writers feel themselves competent to write in multiple fields, with about one-third covering four or more fields of science.

Almost a third, 31%, have had more than 10 years experience, but 38% have been in this field less than five years.

Those below 50 years of age represented 71.1%. Of the 249 giving information, 67 or 26.9% were members of the National Association of Science Writers.

The influence of the youth program is shown by the fact that 89 science writers, 35.8%, reported that they have been members of a science club in high school or have had a science hobby.

The SCIENCE SERVICE Conference on Training for Science Writers was supported by the National Science Foundation and brought together representatives from schools of journalism that have given particular attention to science writing curricula. It also included representative newspaper editors, science writers and scientists.

From the conference it is expected that guidance will be given on future programs to facilitate and encourage better science reporting on American newspapers.

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PHYSIOLOGY

Split Brains Learn Tasks In Half the Normal Time

➤ IF MEN, like experimental monkeys and cats, had their brains split down the middle, they could learn twice as fast as usual.

The reason: The corpus callosum, the largest connection between corresponding structures in the right and left halves of the brain, can be cut with surprisingly little disturbance of ordinary behavior. The split brain then behaves as if it were two separate brains. The right side can learn one task while the left side learns something different. The two sides can even learn tasks that contradict each other.

Monkeys with both the corpus callosum and the right-left eye connections severed, for example, have learned with one side of the brain that pushing circular-shaped buttons will release food. At the same time, the other brain half, through the eye to which it is connected, learned that pushing square buttons brought reward.

In other words, the split-brain monkey can learn two problems in the length of time it takes a normal monkey to learn one problem.

Dr. R. W. Sperry of the California Institute of Technology, Pasadena, in analyzing recent experiments, reports in Science, 133:1749, 1961, that this "raises some questions with regard to learning theory and the role in learning of attention, motivation, mental and motor set, and the like."

The advent of the split-brain animal has opened up a whole new world of experimental possibilities "just waiting to be explored."

Brain bisection is being applied to a wide variety of human problems, he states. But "evidence is still sketchy regarding the extent to which the divided hemispheres can function independently with respect to emotion."

It is conceivable that neuroses can be confined to one brain half while the other side remains normal. Such studies can provide vitally needed background information about the workings of the brain.

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