A History of Teaching Machines

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ABSTRACT: The development of teaching machines is traced from the patented educational devices of the 19th century through the initial teaching machines of Sidney Pressey in the 1920s to the machines invented by B. F. Skinner in the 1950s. The obscurity of Pressey's pioneering work in this field contrasted with the fame achieved by Skinner is discussed in a historical context. The final sections discuss the short-lived success and eventual failure of classroom teaching machines in the 1950s and 1960s.

The latest report from the Dean
Concerning the teaching machine
Is that Oedipus Rex
Could have learned about sex
By machine and not bothered the Queen.
    —(cited in Skinner, 1983, p. 200)

The December 1957 issue of *Contemporary Psychology (CP)* marked the completion of the journal's second year of publication under the editorship of America's premier historian of psychology, Harvard University's Edwin G. Boring. In his monthly column, entitled "CP Speaks," Boring praised the recent publication of a laboratory manual of operant conditioning methods authored by Lloyd Homme and David Klaus. As an aside, he commented that Homme was visiting at Harvard where he was "working on another idea that originated with [B. F.] Skinner, the technique for teaching by machine" (Boring, 1957, p. 313). Boring, who in his historical writings had cautioned that origins are rarely unequivocal, should have known better than to make such an assertion of priority. What historians call an origin myth might have been in the making except for the action of Ohio State University psychologist Horace English who wrote to Boring on January 30, 1958:

When the public press gave Skinner credit for originating "teaching by machine," it did not seem worth while to protest. But when the scholarly editor of CP falls into this trap; dear, oh dear. Be it known that Sidney Pressey *published* descriptions of machines which gave reinforcement by immediate knowledge of results and of one machine which gave reinforcement in the form of a piece of candy—when the child pressed the right lever, if you please. There have been at least six doctoral dissertations devoted to finding the effectiveness of such machines. . . . Most of this was before our friend Skinner even finished grade school. Originate, indeed!. . . . This note is not for publication but it should lead to some sort of correction. Sidney hasn't said beans in my hearing; maybe he does not know of Skinner's new proposal. Does Skinner have any idea of the wealth of research that has preceded him?

In fact, B. F. Skinner did know about Pressey's work, and Pressey was familiar with what Skinner was doing. Of the foursome, only Boring was unaware of Pressey's early work, and the letter from English elicited the following prompt response from the embarrassed 71-year-old editor:

While it's a nuisance not being omniscient, I remain much more interested in education than in defense of the acts of this fallible organism that I call Me. Error often promotes truth, and this error could produce a good note on the history of teaching machines, using CP to belabor. I'll beg Sidney to write such to CP. If he will not, I ask you to do it. (Boring, 1958b)

Two days later Boring had lunch with Skinner and learned that Skinner had known of Pressey's work since 1954. He wrote again to English and to Pressey suggesting that Skinner be asked to write a brief history for CP and suggested that English could respond to it if he found it incorrect. The correction eventually appeared in "CP Speaks" in Boring's name but probably with Skinner's assistance. "Here comes Horace B. English, on his familiar charger, right to the door of CP's tent, defending the honor of Sidney L. Pressey who invented a teaching machine before Skinner had even got to Hamilton College" (Boring, 1958a, p. 152). Boring's correction was full of apologies to Pressey. It also distinguished between the machines of Pressey and Skinner, noting that Pressey's devices depended on trial and error, whereas Skinner's sought to eliminate errors and provide the learner with a series of small successes. Boring learned of that distinction and others in his luncheon with Skinner, although he wrote to English and Pressey that he "did not fully understand the difference" (Boring, 1958c).

Anticipations of the Teaching Machine

The *Contemporary Psychology* correction also quoted Skinner as saying that he doubted whether the originator of the teaching machine could be identified. Skinner stated that although Pressey was the first psychologist involved with teaching by machine, the U.S. Patent Office issued a patent in 1866 (wrongly identified as 1886 in the journal) to Halcyon Skinner for a device for teaching spelling. Subsequently, at least three authors writing on teaching machines gave credit to Halcyon Skinner for inventing the first teaching machine (see Cook, 1962; Holland, 1960; Mager, 1959). However, his device, although a machine, did not teach.

The identification of the earliest teaching machine is dependent on one's definition of such machines. Various aids and devices have existed from the beginnings of education—from charts, maps, and models to filmstrips and videotapes. However, many of these, although assisting learning, do not in fact teach. Agreement on a

Figure 1
Patent Diagrams of Halcyon Skinner's Device for Teaching Spelling
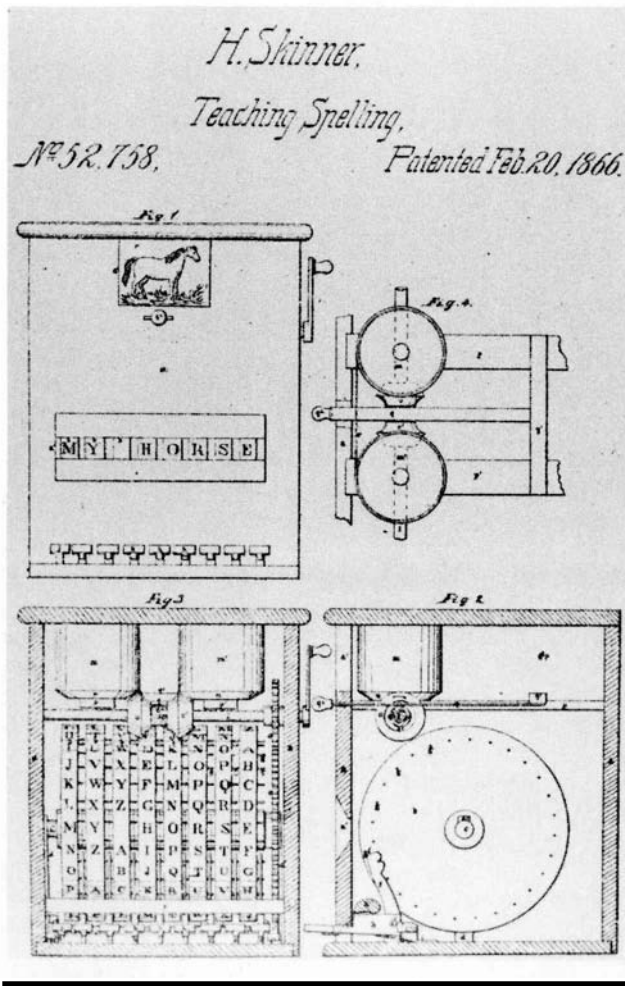
definition of teaching machines is not absolute (see Fry, 1960; Holland, 1961; Morrill, 1961); however, a consensus definition might read as follows: A teaching machine is an automatic or self-controlling device that (a) presents a unit of information (B. F. Skinner would say that the information must be new), (b) provides some means for the learner to respond to the information, and (c) provides feedback about the correctness of the learner's responses.

The device patented by Halcyon Skinner (see Figure 1) performed only the first two functions. A pictorial scroll at the top of the apparatus was moved by a hand crank,

successively exposing a series of pictures (e.g., the horse shown in the figure), thus providing the unit of information. The task of the student was to spell an appropriate word or words, for example "my horse." Words of up to eight letters in length could be spelled by pressing the keys on the front of the apparatus. Those keys provided the response requirement of the definition, and they moved the eight interior letter wheels, each of which contained the 26 alphabet characters and a blank space. However, the machine did not give any feedback about the correctness of the response. The subject could give any number of correct or incorrect spellings and would never know the accuracy of such responses. Thus, this 1866 device for teaching spelling was not a teaching machine.

Halcyon Skinner's device is one of many educational aids that have been patented as educational appliances, devices, and apparatuses. The earliest patent of an educational invention was registered in 1809 for a method of teaching reading. By 1936, there were nearly 700 devices patented for educational uses (see Mellan, 1936). Yet only a few of these meet the criteria specified in the earlier definition. Most fall short on one or more dimensions. For example, George Altman's apparatus for teaching arithmetic, patented in 1897, was self-controlling, provided a means for the learner to respond, and provided feedback about the correctness of the response. It did not, however, present the learner with a unit of information to initiate the response.
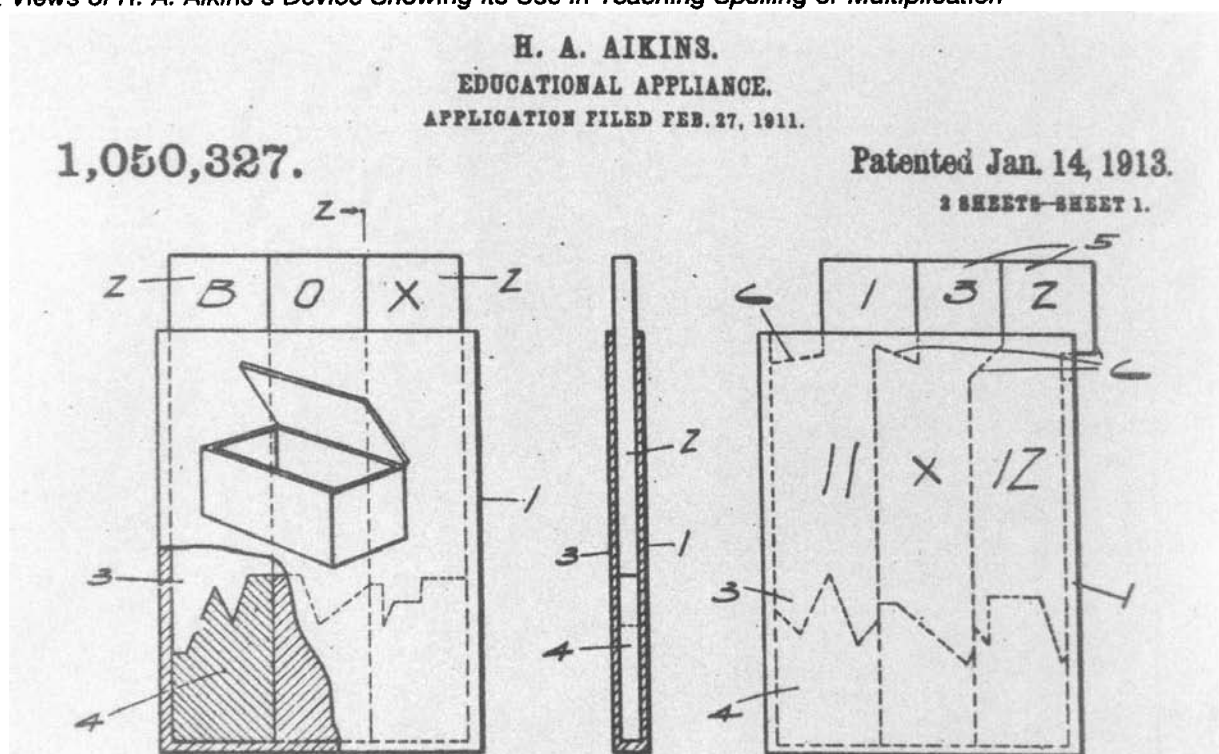
Perhaps the earliest device patented by a psychologist was an educational appliance devised by Herbert Austin Aikins in 1911 that was flexible enough to teach "arithmetic, reading, spelling, foreign languages, history, geography, literature or any other subject in which questions can be asked in such a way as to demand a definite form of words . . . letters . . . or symbols" (Aikins, 1913, p. 3). Aikins earned his doctorate in psychology at Yale University in 1891, likely with G. T. Ladd, and spent his academic career at Western Reserve University in Cleveland. His device (see Figure 2) presented the learner with information, provided a means for response, and indicated the correctness of the response. It was not an automatic or self-controlling device, however; instead, it consisted of a wooden case into which wooden blocks were fitted. Although not a teaching machine, the Aikins device is of special interest to psychology because it is the first teaching aid to cite psychological research as a basis for its design. Drawing on research obviously done by Edward L. Thorndike (1911), Aikins's patent claims to provide a trial and error situation for the learner while reducing the irrelevant cues that might impede learning:

Now, recent experiment [sic] with children and animals show that a vast amount of learning depends upon what is ordinarily known as "trial and error," where the desired act in response to a given stimulation is rewarded by a desirable result . . . But in all such experiments there is great danger that the child or animal will respond, not to the signal, or part of the signal, that seems the one essential thing to the experimenter, but to some concomitant element that the experimenter had ignored altogether. . . . Among the objects sought by the present invention

H. A. AIKINS.
EDUCATIONAL APPLIANCE.
APPLICATION FILED FEB. 27, 1911.

1,050,327.

Patented Jan. 14, 1913.

2 SHEETS—SHEET 1.

Note. Irregular notches in the case are to be matched with notches on three wooden slides in a lock and key arrangement. Correct allignment of the letters "Box" or numbers "132" occur only for the appropriate pictured object or multiplication problem.

accordingly, is such elimination of inconsequential concomitant elements . . . so as to provide a device or appliance in which the learner is necessarily forced to search out and determine the answer deemed desirable (Aikins, 1913, p. 3).

Sidney Pressey's Teaching Machines

In a search of the early patents for educational devices, none were found that appeared to satisfy all criteria in the definition offered earlier until the appearance of Sidney Pressey's initial patent in 1928. Figure 3 shows two of the drawings that appeared in his patent application, originally filed in January 1926. The device was labeled "Machine for Intelligence Tests."

Pressey got the idea for a teaching machine as early as 1915 (Boring, 1958a; Pressey, 1946) while considering ways to use a machine to score objective tests, but World War I delayed his pursuit of this work. He exhibited a working model of the machine at the 1924 meeting of the American Psychological Association (APA) in Washington, DC and, following some minor modifications, exhibited it again at the next APA meeting in Ithaca, New York. Boring was a member of the APA Council of Directors (now called the Board of Directors) for both of those meetings, but it cannot be said whether he witnessed either of Pressey's demonstrations.
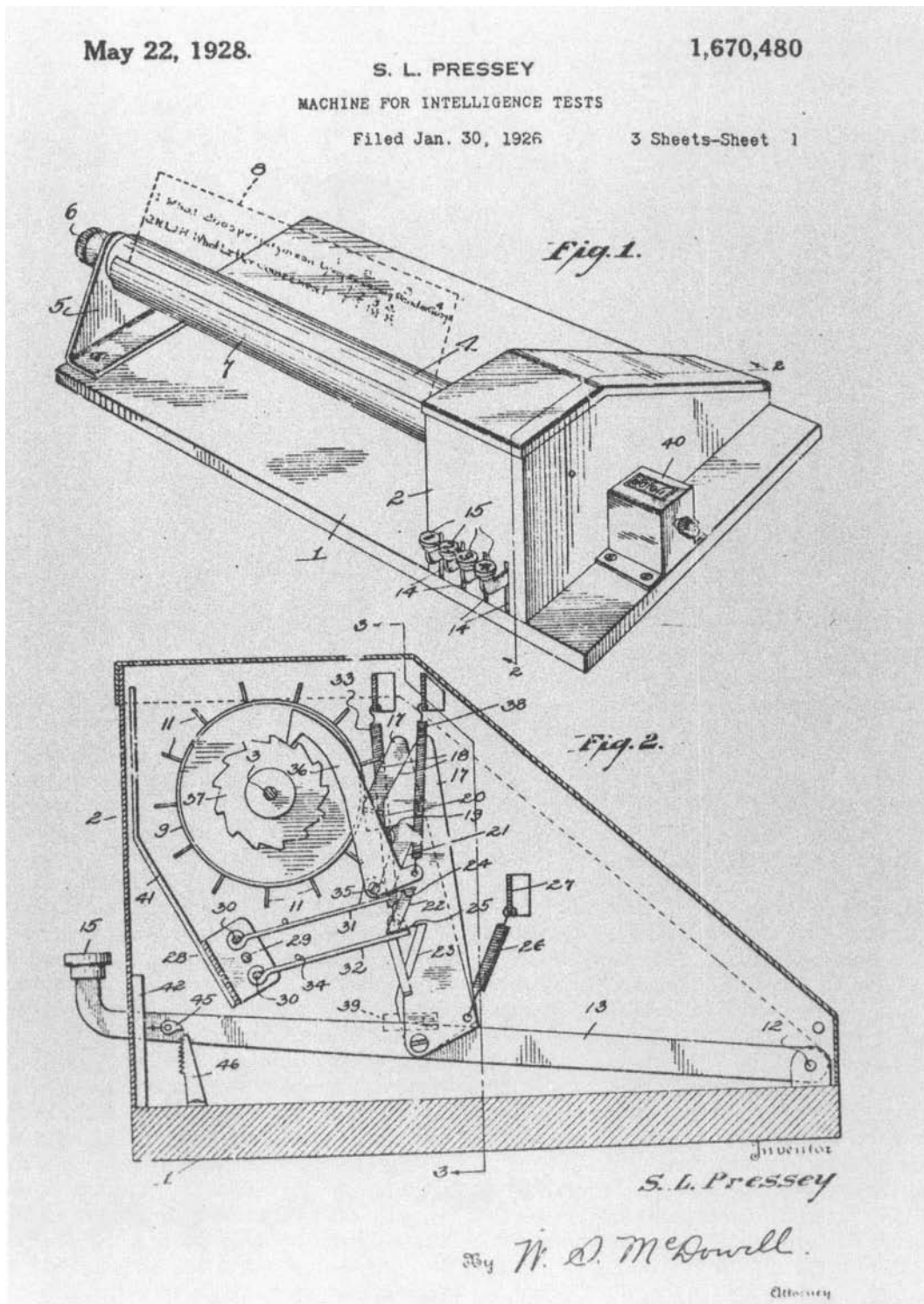
Figure 4 shows the machine Pressey demonstrated at the APA meetings. A large drum with paper attached

rotates and exposes typed or written material in a narrow window. The typed material is essentially a multiple-choice question with four alternatives labeled 1 through 4. The four keys at the right correspond to the four answers, and one of those is depressed by the subject. The machine had two modes of operation, one labeled "test" and the other "teach." In the test mode the subject chose an answer and depressed the corresponding key. The machine recorded that response and advanced automatically to the next question where the subject again responded. A counter on the back of the machine recorded the total number of correct responses.

To use the machine in the teaching mode, a small lever on the back of the machine was raised. This action prevented the machine from advancing to the next question until the previous question had been answered correctly. That meant that the subject could make multiple responses on each question, until the right answer was chosen. The mechanical counter counted all key presses. Pressey believed that this procedure was effective for learning because it operated according to both the law of recency and law of frequency.

He also added an additional attachment to this device that was essentially a candy dispenser. It allowed the experimenter to set what Pressey called a "reward dial," determining the number of correct responses required to receive a candy reward. Once the response criterion had

Figure 3
Patent Diagram of Sidney Pressey's Teaching Machine

May 22, 1928.

S. L. PRESSEY

1,670,480

MACHINE FOR INTELLIGENCE TESTS

Filed Jan. 30, 1926

3 Sheets—Sheet 1

Fig.1.

Fig.2.

Inventor

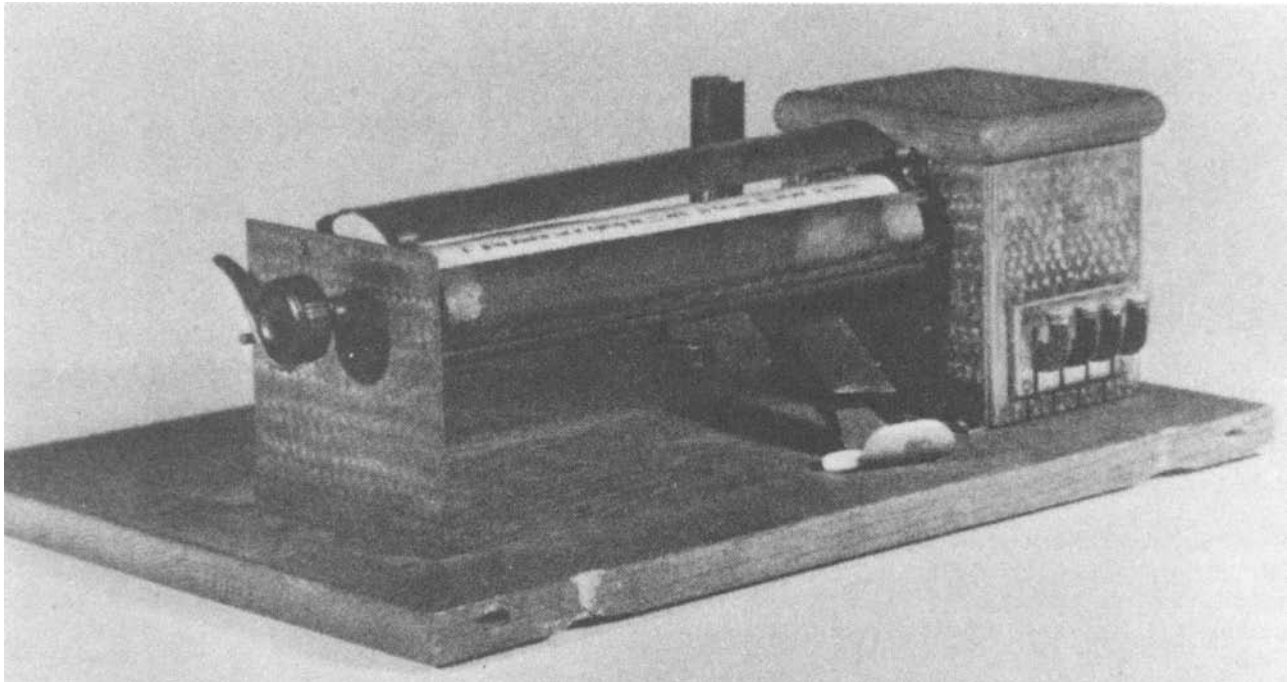S. L. Pressey

By W. D. McDowell.

been reached, the device automatically delivered a piece of candy to a container in front of the subject. A description of this initial teaching machine appeared in the journal *School and Society* in 1926. Pressey's title for the article was "A Simple Apparatus Which Gives Tests and Scores—and Teaches."

Figure 4
The Self-Scoring, Multiple-Choice Teaching Machine Exhibited by Sidney Pressey at the 1924 and 1925 Meetings of the APA

In the following year, he published the description of a second machine in the same journal (Pressey, 1927). This apparatus was intended for teaching drill material and had the unique feature of dropping a question from the testing routine once it had been correctly answered twice in succession. According to Pressey (1927), the advantage of such a program was that it "should prevent excessive overlearning and bring about a concentration of effort on each problem in proportion to its difficulty" (p. 549).

Pressey continued his work on teaching machines, involving his students in research to test the efficacy of the machines when compared to more traditional teaching methods. He also preached about the need for technological solutions to many of the problems of education and predicted an industrial revolution in education. In the final chapter of his 1933 book entitled *Psychology and the New Education*, Pressey wrote,

There must be an "industrial revolution" in education, in which educational science and the ingenuity of educational technology combine to modernize the grossly inefficient and clumsy procedures of conventional education. Work in the schools of the future will be marvelously though simply organized, so as to adjust almost automatically to individual differences and the characteristics of the learning process. There will be many labor-saving schemes and devices, and even machines—not at all for the mechanizing of education, but for the freeing of teacher and pupil from educational drudgery and incompetence. (pp. 582–583)

By the time of that prediction, however, Pressey was already discouraged because of problems in successfully marketing his machines, and he wrote in a 1932 article that he was "regretfully dropping further work on these problems" (p. 672). He was no doubt disappointed in the lack of interest in his devices. He succeeded in getting one of his machines manufactured and distributed by the Welch Scientific Company in Chicago, Illinois in 1930. However, the manufacturer withdrew it, presumably because of lack of sales (Pressey, 1967). Despite his expression of regret in 1932, Pressey did not abandon teaching machines. For example, he presented an update on his continuing research at the 1946 APA meeting in Philadelphia (Pressey, 1946). Judging by the revision of his book on psychology and education published in 1944, he had not abandoned his hope for the industrial revolution in education. The passage from his 1933 book appeared unchanged in the 1944 version (Pressey & Robinson, 1944). Yet for most psychologists, Pressey's work essentially disappeared until it was rediscovered in the midst of what some writers have labeled the teaching machine movement (Rabinowitz & Mitzel, 1962; Wohlwill, 1962), begun by B. F. Skinner.

Why was Pressey unsuccessful in promoting his industrial revolution in education? Skinner (1958) argued that Pressey's machines failed because of cultural inertia—the field of education was simply not ready for them. One way to account for that inertia is to compare the conditions in American society during the early 1930s,

when Pressey was active, with the late 1950s and early 1960s, when Skinner was most active in this area. Pressey's machines, which promised education at a faster pace and a need for fewer teachers, appeared during the Great Depression when there was a great surplus of teachers and no public pressure to increase the pace of education (see Boehm, 1960; Pressey, 1967). Conditions were very different for Skinner.

First, Skinner's work in the 1950s followed on the heels of the initial principal automation of public education, an automation that grew out of World War II. During the war, motion picture films were used successfully in the training of millions of America's military personnel. That success brought about the establishment of audiovisual departments in most large public school systems. This technology was supported by the establishment of the first educational television station in 1953. By 1963 there were 60 affiliates of the National Educational Television Network (see Packer, 1963). Second, by the late 1950s the United States was suffering from a shortage of teachers and the post-World-War-II baby boom promised to exacerbate that problem in the next decade (Luce, 1960). Third, the Soviets had launched Sputnik, an action that was the single largest impetus to a serious examination of the quality of American education, particularly in the fields of science and mathematics. These new machines that promised faster learning, while relieving some of the teacher's burden, were met with an enthusiasm never experienced by Pressey. By 1962 there were 65 different teaching machines on the market, ranging in price from $20 to $6,500 (Kreig, 1961), and nearly 200 private companies were producing teaching machines, programmed texts, or both (Leib et al., 1967; "The Truth About," 1962).

B. F. Skinner's Teaching Machines

B. F. Skinner's initial foray into teaching machines is well documented in the third volume of his autobiography (Skinner, 1983). It began in 1953 with a visit to his daughter's fourth-grade class where he made two observations during an arithmetic assignment: (a) All students had to proceed at the same pace, and (b) students had to wait 24 hours to learn the accuracy of their responses to the problems. A few days later, he built a primitive machine to teach arithmetic. His machine presented a problem, the student moved levers to create the numerical answer, and a light appeared when the answer was correct. He demonstrated a modified machine the following year at a conference on practical applications of behavioral science at the University of Pittsburgh (see Skinner, 1955). In the summer of that year, a brief account of Skinner's teaching machine appeared in Science News Letter ("Teaching by Machine," 1954).

Sidney Pressey read that article and wrote to Skinner, sending him a set of his own teaching machine reprints, including those from the 1920s. Until that time Skinner had not known of Pressey's work. They made arrangements to meet that fall at the APA meeting in New York City where they had breakfast together and had what

Skinner has described as an exciting discussion about teaching machines (Skinner, 1983). Thereafter, when presenting his work, Skinner acknowledged the earlier contributions of Pressey, although that acknowledgment did not appear in print until 1958 in Skinner's article in Science and the brief note in Contemporary Psychology already mentioned (Boring, 1958a). The delay was not because of any reluctance on Skinner's part. Rather it was due to his work on two books, Schedules of Reinforcement (with Charles Ferster) and Verbal Behavior, both of which appeared in 1957.

Although Skinner recognized the value of Pressey's machines, he regarded them principally as testing devices rather than teaching machines. It was true that they gave the students feedback about their answers, but in Skinner's opinion they did not really teach the students new material. In Pressey's machines the students had to study some material prior to using the machine. In contrast, Skinner was developing devices that taught students new material in very small steps. This difference was a critical one for Skinner. He argued that learning proceeded most easily in small steps; thus, student success could be maximized, and errors could be kept to a near zero level. To ensure this kind of learning, the material had to be organized in a coherent fashion, building a response repertoire, step by tiny step. The term programmed learning was coined to describe information constructed in this systematic and logical manner (Skinner, 1958, 1961, 1986).

Pressey welcomed Skinner's enlistment in education's industrial revolution; however, he was not enamored with the single-mindedness of Skinner's approach, particularly as it changed the nature of reading. He cautioned that Skinner's machines would do away with textbooks (Pressey, 1962). He objected to the learning style of the pigeon being used to shape a human technology, in which reading occurred by restricting a person's glance, in Pressey's words, "to the rigid slow serial peep show viewing of innumerable 'frames' " each demanding that the person respond and be reinforced (Pressey, 1963, p. 5).

There was another principal difference between the machines devised by these two men. Unlike Pressey's machine, which required the student to select one of four or five responses in a multiple-choice format, Skinner's machine required the student to construct a response, that is, to write it directly on the paper in the machine. Then the student could compare his or her answer with the correct answer by sliding a panel to the side.

Skinner objected to the multiple-choice format for several reasons. First, it meant exposing the student to a number of plausible wrong answers, a procedure that Skinner regarded as unnecessarily confusing ("Ice Cream," 1968), and one that would lead to the perpetuation of errors. Second, the student should construct a response, rather than select one, thus strengthening a behavior that has greater utility in life. Third, the student should progress to the level of being able to emit a response, instead of just recognizing a given response as correct (Skinner, 1961).

Opponents of Skinner's construction method objected to the limits of the machine's acceptable answers, for example, requiring the word *elicit* and not accepting the synonym *evoke* (Leavitt, 1960). Others criticized the required written response, arguing that it was less effective because it delayed the presentation of the reinforcement ("How Machines Do," 1960). Pressey (1963) argued that research comparing written responses with the objective responses of his multiple-choice method showed the latter to be superior in human learning. The following year Pressey (1964), convinced of the folly of Skinner's programming technique, issued a "plea" for a critical review of the method.

Despite the arguments, the hour belonged to Skinner. He had produced more than a machine; he had developed an educational technology that promoted a new approach to teaching (Holland, 1960). The boom in teaching machines was underway in the early 1960s, and most of the devices were based on Skinner's theory of learning. One of the most popular machines was the Min-Max, marketed by Grolier, Inc. The company initially sold the Min-Max door to door, using its force of 5,000 encyclopedia salespeople ("The Teaching Machines," 1960). The machine, which was designed by Teaching Machines, Inc., a company headed by psychologist Lloyd Homme, was one of the cheapest on the market at $20, and within two years Grolier had sold 100,000 of them ("The Truth About," 1962). The company sales representatives used Skinner's and Harvard University's name in its marketing despite requests from Skinner that they stop (Skinner, 1983).

Skinner's own attempts to market a machine had not gone well. He began working with the IBM Corporation and later with the Rheem Company, but neither arrangement worked out well. The details of those trials and tribulations are described in the third volume of Skinner's autobiography (see Skinner, 1983).

The 1960s: Rise and Fall

By the early 1960s, teaching machines were much in the news. National and international conferences were held to discuss the new technology, and popular magazines and scientific journals published news of the emerging research and applications. A survey of the *Readers' Guide to Periodical Literature* shows two citations for teaching machines prior to 1959; both were articles authored by Skinner. For 1959–1960, there were 20 articles in popular magazines and another 31 in 1961–1962. A similar trend can be seen in the scientific literature where "teaching machine" was initially used as an index term in the 1960 volume of *Psychological Abstracts*, which listed 12 entries. In 1961, that number increased to 20, and the following year to 24 entries. Interest was shown not only by the educational establishment but also by industry and the military who were especially interested in training applications.[1]

All the news was not good, however. There were many articles, particularly in the popular press, that cautioned the public about the potential evils of these ma-

chines. The titles of these articles, almost always written as a question, echoed the range of concern: "Can People Be Taught Like Pigeons?" (Boehm, 1960); "Can Machines Replace Teachers?" (Luce, 1960); "Teaching Machines—Blessing or Curse?" (K. Gilmore, 1961); "Will Robots Teach Your Children?" (Bell, 1961); "Do Teaching Machines Really Teach?" (Margolis, 1963); "Which Is It? New World of Teaching Machines or Brave New Teaching Machines?" (Morello, 1965).

The dehumanized future described by Huxley and Orwell was a frequent critical theme of these articles, depicting human lives controlled by machines (see Greene, 1968). One author wrote about the concern of "robots taking over classrooms—Miss Univac replacing Our Miss Brooks!" (Kreig, 1961, p. 45). The author of an article in *Today's Health*, worried by the emphasis on early education and teaching machines, wrote, "I wouldn't be surprised to see an intra-uterine teaching machine on the market before this insane approach to learning and growing ends" ("The Critics Speak," 1967, p. 57).

A corollary to the dehumanization view was the assertion that students would receive less personal attention in the classroom. That concern was frequently espoused by parents and teachers. New York University Chancellor George Stoddard wondered whether "a live teacher who infuriates a student is better than a machine that leaves him stuffed with information but cold as a mackerel" (Morello, 1965, p. 14). Skinner's arguments, that the individualized instruction of teaching machines meant more personal attention for the students, often fell on deaf ears (see Skinner, 1980, pp. 97, 273). Some users of the machines lauded them as superior private tutors (Blyth, 1960), but those who held sacred the traditional teacher–student bond were not willing to accept a mechanical substitute.

Another theme of criticism was whether these machines could really teach and, if so, what were they capable of teaching? Skinner argued that anything that could be verbalized could be taught by a teaching machine ("The Critics Speak," 1967), but others felt the programs worked well only for those subjects that were easily fragmented, for example, foreign languages and mathematics. One critic noted that it might be possible to learn a poem using one of the machines, but the machine could not teach the love for poetry (Margolis, 1963). Related to these criticisms was a concern that the machines might be less than maximally effective because teachers were not adequately trained in using the new technology (Rabinowitz & Mitzel, 1962). Yet some worried that the machines could teach too well, placing a nation of learners in the hands of a master programmer. Imagine what use a Hitler or Stalin could have made of such programming, warned one magazine ("The Critics Speak," 1967).

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[1] This historical account of teaching machines is restricted to their use in traditional classrooms and does not treat military and industrial applications of those devices. Reviews of some of the early usage in the military and industry can be found in Briggs (1959), Christian (1962), Leib et al. (1967), and Silvern (1962).

Another criticism of the machines was that they were unnecessary for the presentation of programmed learning materials. One critic put it succinctly by calling them "expensive page turners" ("The Truth About," 1962). Skinner and other proponents argued, however, that the machines controlled the presentation of material and prevented cheating (Holland, 1961). Further, the machine provided a record of the student's performance. Also not to be overlooked was the fact that children, and even adults, enjoyed using the machines.

A most important, and frequently repeated, concern was the impact of the machines on teachers, specifically that teachers would lose their jobs because of the machines. Some educators saw the machines as an excuse for administrators to increase the student–teacher ratio (Broudy, 1962). Proponents of the machines argued that they would handle much of the classroom drudgery, freeing the teachers for duties more suited to their professional training. In classes where the machines were used, teachers often reported great satisfaction with them (see Luce, 1960), although such reports likely did little good in reducing the fear of others. Several magazines noted that the teacherless school seemed a reasonable possibility (see "The Critics Speak," 1967). In at least two instances, pressure from teachers led school administrators to seek legislation that would ban teaching machines from the classroom (Morello, 1965). Despite the teacher shortage being faced in the United States, concern among teachers was evident.

Other serious concerns involved the corporate claims for the machines and ways in which they were marketed. One school district spent $5,000 on machines and discovered there were no programs available for them. Some machines seemed little more than toys, offering almost no educational benefits (Weisenberg, 1961). Several of the relevant professional organizations grew concerned about these and other problems and sought to develop guidelines that would aid consumers. The American Educational Research Association, National Education Association, and APA all collaborated on a joint statement on "Self-Instructional Materials and Devices" (1961) and a lengthier report ("1962 Interim Report," 1963). Richard Crutchfield, James Holland, and Lawrence Stolurow were the APA representatives on the Joint Committee. The published report emphasized the importance of successful programs in providing quality teaching by machine and listed criteria for assessing program effectiveness. The Committee cited a need for research on the relative effectiveness of different types of programs but did not call for research comparing teaching machine with more traditional teaching methods.

Not surprisingly, psychologists were divided on the efficacy and desirability of these devices. University of Alabama psychologist Thomas Gilbert left little doubt about his feelings when he stated,

If you don't have a gadget called a "teaching machine," don't get one. Don't buy one; don't borrow one; don't steal one. If you have such a gadget, get rid of it. . . . The so-called teaching machine is a disease. (in Boehm, 1960, p. 260)

Joachim Wohlwill (1962) called teaching machines "psychology's new hobbyhorse" and argued that the philosophy of education underlying the machines was seriously flawed, particularly because differences in cognitive functioning were ignored. Reflecting on all the rhetoric of his decade of work on teaching machines, Skinner (1965) wrote, "Those who have had anything useful to say have said it far too often, and those who have had nothing to say have been no more reticent" (p. 5).

In 1962, at the height of the teaching machine movement, Norman Crowder predicted that by 1965 half of all American students would be using teaching machines for one or more courses (C. Gilmore, 1962). The industrial revolution in education that had been forecast by Pressey and others (see McClusky, 1934) for so long now seemed at hand. In the words of Skinner, at last the schoolroom would be as mechanized as the kitchen (Seligman, 1958). It was not to be, however. By the late 1960s many of the machines had been withdrawn from the market, programs on teaching machines became scarce at educational conferences, and articles debating whether they were a blessing or a curse had all but disappeared from the popular press. Evidence of the marked decline in interest is shown in the decreasing publications on teaching machines after 1964. For the popular literature, citations in the *Readers' Guide to Periodical Literature* were greatest between 1960 and 1964 (65 citations). For 1965–1969 that number declined to 23, and in 1970–1974 to only 5. A similar pattern is shown in citations in *Psychological Abstracts,* where there were 101 citations for 1960–1964, 22 for 1965–1969, and 15 for 1970–1974.

There were still a number of educators and psychologists who labored for the cause, but for most of the public, including school teachers, it had ceased to be a topic of interest. Some of the teaching machine supporters shifted their hopes to the rapidly developing computer and the concept of computer-assisted instruction (CAI). CAI was an outgrowth of the Teaching Machine Project at the IBM Research Center in the late 1950s. Two of the initially successful CAI programs were developed in the 1960s—the IBM 1500 Instructional System by researchers at Stanford University (see Atkinson, 1968) and the Programmed Logic for Automatic Teaching Operations (PLATO) at the University of Illinois in cooperation with Control Data Corporation (Pagliaro, 1983). However, use of computers in the classrooms of the 1960s and 1970s was very minimal. Even Skinner, in a 1968 interview for *Forbes* magazine, doubted the future of the computer as a teaching machine ("Ice Cream," 1968).

Classroom Computers in the 1970s and 1980s

Initially, cost was a major problem negating use of computers in the classroom, and programs were not "user friendly." But rapid developments in microprocessors and other components led to the availability of fully assembled microcomputers for the general public by the late 1970s. Further improvements in hardware and software, as well as reduced costs for both, have made computers commonplace in the classroom and home in the 1980s. How

large a role is the computer playing in the classroom as a teaching machine? The short answer is that this latest generation of teaching machine continues to be an adjunct to classroom instruction.

Teachers recall the promises made for earlier educational technologies that were supposed to revolutionize teaching. Perhaps they are more cautious in their acceptance of computers. Among many teachers who use computers, the devices are viewed as an aid to teaching rather than as an integral part of the educational process (Martellaro, 1980). Some of the same technological fears of earlier machines, including dehumanization, are directed at computers (Sardello, 1984), and developmental psychologists caution about the deleterious effects of computer teaching on cognitive structures in children (Zajonc, 1984). Technological problems also exist, including a lack of good quality educational software for courses, difficulties in transferring programs across systems, and problems in recording individual student and class responses for grading and record keeping (Pagliaro, 1983). The titles of articles in the popular magazines of the 1980s sound all too familiar—"Computers in the Classroom: Are They Making the Grade?" (1985). The fear of an Orwellian generation of robot-like children sitting passively in wholly automated classrooms has not come to pass. Today children spend much of their time staring at a screen, but it belongs to their televisions, not their computers.

Conclusions

In concluding this brief history of teaching machines in the classroom, it has been shown that they emerged in the 1920s at the hand of Sidney Pressey and were largely confined to the dissertations of a handful of Ohio State University doctoral students. They reappeared in the 1950s with the work of B. F. Skinner and enjoyed considerable popularity through the early 1960s. By the late 1960s, they had gone the way of hula hoops, only to be reincarnated in the personal computers of the 1980s. The vision of machines carrying the brunt of the instructional role in a mechanized classroom of multiple child–machine pairs has never materialized; these machines remain as minor adjuncts to the educational process. Psychologist Robert Daniel (1985), a long-time observer of teaching practices, said that is as it should be. Teaching machines are successful as a supplement to but not as a substitute for the teacher. Daniel speculated that some of the failure of the machines was due to teachers who expected the machines to perform roles that could only be handled by the human teacher.

Why did teaching machines fail to live up to the expectations of their supporters? Likely it was not because they were not effective; there were many studies that attested to their success in teaching (see Pressey, 1963; Silberman, 1962; Skinner, 1965), although some studies found no differences in learning outcomes (see Carter, 1966; McKeown, 1965; Stolurow, 1961). It seems unlikely that cost was a significant factor; many of the machines used in the schools were quite inexpensive, and repair

costs were minimal. It cannot be because of a lack of sufficient programs; by the mid 1960s there were thousands of available programs across a wide variety of school subjects. So what went wrong?

Perhaps the cultural inertia that Skinner referred to in Pressey's time still exists today, at least with regard to the American educational system. Over the past 50 years a number of new approaches have promised to supplant the teacher or at least substantially alter the teacher's role in the classroom. First it was movies, then teaching machines and programmed instruction, then television, then personalized system of instruction (PSI) courses, and now computers. Yet it can be argued that none of these technologies has lived up to its advanced billing. They have all played a role in education and continue to do so, but it is a minor role. Daniel (1985) argued that all of these technologies failed, in part, because they distanced the student from a living, breathing teacher. Perhaps that validates the effectiveness of the teacher–student bond that has existed since the beginning of education, or perhaps it only underscores the paranoia about machines that technological proponents have long lamented. Maybe it is simply old-fashioned resistance to change. Whatever the reasons, Skinner has not given up the fight as evidenced in his 1984 article "The Shame of American Education." However, if past behavior is a predictor of future behavior, then it seems unlikely that computers or any other teaching machines will play more than a supporting role in the classroom.

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