

Audrey Watters, *Teaching Machines: The History of Personalized Learning* (MIT Press, 2021)

Book Excerpt 3

National Center for the Study of Privatization in Education

Teachers College, Columbia University

November 22, 2021

In the fall of 1953, Harvard psychology professor B. F. Skinner visited his daughter's fourth grade math class at Shady Hill, a private school in Cambridge, Massachusetts, where he observed the teacher and students with dismay. The students were all seated at their desks, working on arithmetic problems written on the blackboard as the teacher walked up and down the rows of desks, looking at the students' work, pointing out the mistakes that she noticed. Some students finished the work quickly, Skinner reported, and squirmed in their seats with impatience, waiting for the next set of instructions. Other students squirmed with frustration as they struggled to finish the assignment at all. Eventually the lesson was over; the work was collected so the teacher could take the papers home, grade them, and return them to the class the following day.

“I suddenly realized that something must be done,” Skinner later wrote in his autobiography.¹ The classroom activities violated two key principles of his behaviorist theory of learning. Students were not told *immediately* whether they had an answer right or wrong. A graded paper returned a day later failed to offer the type of prompt and positive feedback that Skinner believed necessary to modify behavior—that is, to learn. Furthermore, the students were all forced to proceed at the same pace through the lesson, regardless of their level of ability or comprehension. This method of instruction provided the *wrong sort* of reinforcement, Skinner argued, penalizing the students who could move more quickly as well as those who needed to move more slowly through the materials.

A few days later, Skinner built a prototype of a mechanical device that he believed would solve these problems—and solve them not only for his daughter's classroom but ideally for the entire education system. His teaching machine, he argued, would enable a student to progress through exercises that were perfectly matched to her level of knowledge and skill, assessing her

1. B. F. Skinner, *A Matter of Consequences* (New York: Alfred A. Knopf, 1983), 64.

understanding of each new concept, and giving immediate feedback and encouragement along the way.

It was a “primitive” machine, Skinner admitted, fashioned out of a rectangular wooden box. “Problems in arithmetic were printed on cards,” he explained. “The student placed the card in the machine and composed a two-digital answer along one side by moving two levers. If the answer was right, a light appeared in a hole in the card.”² He quickly built a second model in which a student manipulated sliders bearing the numbers 0 through 9 in order to compose an answer. In another prototype, the student turned a knob after setting the answer. If the answer was wrong, the knob would not turn. If the answer was right, the knob would move freely, and a bell would ring.

A ringing bell is associated with some of the earliest and most famous experiments in behavior modification, namely those of the Russian physiologist Ivan Pavlov. Pavlov had published his research on dogs in 1897, describing how he’d conditioned the animals to respond to a bell by salivating—work for which he would later win the Nobel Prize in Medicine.

Skinner’s own research was, to a certain extent, built on Pavlov’s, moving from what was considered the “classical conditioning” of involuntary responses—stimulating salivation with food, for example—to an “operant conditioning” of voluntary ones. By using operating conditioning—that is, by administering rewards or punishments—all sorts of behaviors could be manipulated, Skinner argued, not simply reflex responses; and these behaviors could be bolstered through “schedules of reinforcement,” the title of Skinner’s 1957 book cowritten with colleague Charles Ferster.³ Although Skinner insisted that he and Pavlov “were studying very different processes,” the Russian scientist was incredibly influential on the early science of learning in general, focused as it mostly was on animal rather than human behavior.⁴

For Skinner, studying learning meant studying behavior, and vice versa. “For me,” he wrote in his autobiography, “behaviorism was psychology.”⁵ Skinner contrasted this with “mentalism,” a belief to which he would frequently accuse his fellow students and professors of

2. Skinner, *A Matter of Consequences*, 65.

3. Charles Ferster and B. F. Skinner, *Schedules of Reinforcement* (New York: Appleton-Century-Crofts, 1958).

4. B. F. Skinner, *Particulars of My Life* (New York: Alfred A. Knopf, Inc., 1976). 301.

5. B. F. Skinner, *The Shaping of a Behaviorist* (New York: New York University Press, 1979), 4.

ascribing. By “mentalism,” Skinner meant both Freudian and Jungian analysis—that is, ideas about consciousness and unconsciousness, ideas that had garnered significant popular not just scientific appeal in the early twentieth century. One could not observe or verify what happens in “the mind,” behaviorists like Skinner contended, and therefore “the mind” itself could not really be examined through scientific experimentation or inquiry. Indeed, in reviewing Carl Jung’s book *Psychological Types* in 1923 for the *New Republic*, behaviorist John B. Watson—arguably the best known American behaviorist before Skinner—dismissed the work of the Swiss psychoanalyst as relying on “unjustified and unsupportable assumptions,” on “magic” and not science.⁶ Scientific study, behaviorists insisted, meant analyzing activities—*behaviors*—rather than speculating about inward motivations or sensations.

Skinner described his approach as *radical* behaviorism, which he argued “does not deny the possibility of self-observation or self-knowledge or its possible usefulness, but it questions the nature of what is felt or observed and hence known. . . . The position can be stated as follows: what is felt or introspectively observed is not some nonphysical world of consciousness, mind, or mental life but the observer’s own body.”⁷ Rather than seeing “the mind” as entirely beyond scientific inquiry, Skinner argued that one could actually examine events “taking place in the private world within the skin”⁸—but one must do so through a behaviorist lens. This meant that language and learning, as historian of psychology Alexandra Rutherford points out in her work on Skinner’s cultural impact, “all come under the purview of the experimental analysis of behavior, but they are radically reconceptualized as forms of behavior ultimately dependent on the external or social environment for their development.”⁹

If behavior was controlled (and controllable) by the environment, then what better way to make adjustments to individuals—and, as Skinner imagined, *to all of society*—than by machine.

Skinner’s commitment to behaviorism was not simply “academic,” a term that is often used to suggest a theory divorced from practice. Skinner was a best-selling author, a public

6. John B. Watson, “Jung as Psychologist,” *New Republic* (November 7, 1923), 88.

7. B. F. Skinner, *About Behaviorism* (New York: Vintage Books, 1976), 18.

8. Skinner, *About Behaviorism*, 18.

9. Alexandra Rutherford, *Beyond the Box: B. F. Skinner’s Technology of Behavior from Laboratory to Life, 1950s–1970s* (Toronto: University of Toronto Press, 2009), 162.

Watters, *Teaching Machines* • NCSPE Book Excerpt

intellectual, a “visible scientist.”¹⁰ He was an inventor of psychological gadgetry and a promoter of what Rutherford has called “a technology of behavior”—a technology that, despite Skinner’s rather controversial reputation, has “become a clearly identifiable component of life beyond the laboratory.”¹¹ Indeed, Rutherford argues that “Skinner’s most enduring cultural legacy is his technology of behavior, rather than his experimental science or his philosophy of radical behaviorism.”¹²

And that is a legacy that is foundational for education technology. It’s not where the story of teaching machines begins, but it’s almost always how the story of teaching machines ends: deeply intertwined with Skinner and with his psycho-technologies. It is a foundation from which education technology has never entirely broken.

10. Rae Goodell, *The Visible Scientists* (Boston: Little, Brown and Company, 1977).

11. Rutherford, *Beyond the Box*, 23, 153.

12. Rutherford, 153.