Audrey Watters

Teaching Machines: The History of Personalized Learning

Cambridge: MIT Press, 2021. 328 pp.

Audrey Watters' *Teaching Machines* is an account of the birth, rebirth and re-rebirth of an idea: personalized learning (read: self-paced, not self-directed) for school-aged children, organized via machines designed based on psychological research. Her book demonstrates how teaching by machine is repeatedly presented as new, when it in fact dates back at least to the 1920s and the work of Dr. Sidney L. Pressey of Ohio State University. Teaching machines promised three advantages to the relatively new, complex, and expensive American public education system: cost savings; freedom for students to self-pace; and the liberation of teachers from grading.

Pressey's efforts notwithstanding, machines to automate teaching are more famously associated with the later work of Dr. B. F. Skinner at Harvard University, whose dogged determination, motivations, and personality assume centre stage in Watters' story. Through his archived correspondence with his colleagues, business partners, and even his attorney, she lays bare Skinner's hunger to have teaching machines find dominance in American education — and to take primary credit for this change.

Of course, teaching machines have yet to dominate the education of school-aged children. Watters posits several explanations, including teacher resistance (which she claims has not been decisive); inadequate evidence of the machines' practicality and benefits in the existing school system; students' lack of enthusiasm for machine-mediated lessons; and lack of commitment on the part of commercial partners. This reviewer particularly appreciated Watters' exploration of Skinner's relationship with the Rheem Corporation and the company's continued re-organization, dithering, and doubt about the teaching machines agenda. Indeed, Watters demonstrates through multiple cases, spread across decades, the general reticence that capital has had to invest in the education market and in learning scientists' ideas.

However, I do not believe this book was written as a cautionary tale for would-be education entrepreneurs. If not, for whom *was* this history of teaching machines from the 1920s through the 1970s written? Apparently, for all of us. In the closing chapters Watters displays concern with looming threats to personal freedom in the present century: especially surveillance capitalism[6] (and its cousin, learning analytics) meant to predict and control human behavior, and driven by ubiquitous online tracking. These threats are indeed terrifying; and Watters' text attempts to offer comfort by highlighting how developers and promoters of teaching machines have repeatedly botched the job in some way.

Should this give us comfort? In her first chapter, Watters asserts that "To understand

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6 Shoshana Zuboff provides a detailed account of surveillance capitalism and its dangers. Shoshana Zuboff, *The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power.* New York (Public Affairs, 2019).

the teaching machines of the mid-20th century is to understand those of today" (15). For my entire career I have taught university students about contemporary computer-based, artificially intelligent tutors in order to let them interrogate both the potential and the limitations of such teaching machines. I have often used free demonstrations of AI-based tutoring software from Carnegie Learning, a privately held, for-profit spinoff of Carnegie Melon University. Though Watters does not mention them, Carnegie's products provide a good test case for Watters' suggestion that the future of teaching machines could be much like its past.

I recall one of my master's students proclaiming that he had learned more algebra in twenty minutes with a Carnegie tutor than he had learned in a whole year of high school. However, the majority of my students have expressed frustration with the tutors. Establishing mastery is their central goal; so, they make each student solve many problems of the same type flawlessly before they can move on to another type. In practice though, not all students *want* mastery.[7] If all you want is to *get through* a required algebra class, a mastery-based teaching machine can feel like a prison for your mind. This is a good deal worse than the boredom that earlier teaching machines sometimes evoked by Watters' account, and it raises an important question: If it ever became possible for schools to demand complete mastery of the curriculum from every student, would we decide to have the same curriculum at all? I personally doubt this.

As someone who has worked in educational technology and learning sciences for three decades, I found Watters' narrative gripping and bristling with insight. Indeed, I feel that it does substantial service to my field by drawing general attention to some perennial weaknesses in its research and innovations. One is our chronic inability to convincingly address Hawthorne effects: The possibility that outcomes from early research are not due to the properties of an innovation itself, but to the fact that research participants are aware that they are being offered something special that is supposed to benefit them. Watters also brings up the irony that technological innovations are often touted as promoting a more natural (?!) way to learn. Finally, there is the fact that despite most of the *teaching* in America being carried out by women, teaching *machines* have largely been championed by men — and the few women involved have received hardly any credit for their work.

Will teaching machines have a substantial place in education this century, and will they stick around *this* time? I only hope that those tasked with deciding will take the time to read this excellent book.

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7 Carnegie Learning's own published research suggests as much. See Steve Ritter, Michael Yudelson, Stephan E. Fancsali and Susan R. Berman, "How Mastery Learning Works at Scale" (New York: Association for Computer Machinery, 2016).