Bill Ferster. *Teaching Machines: Learning from the Intersection of Education and Technology.* **Baltimore, MD: Johns Hopkins University Press, 2014. 199 pp. Hardcover: $34.95. ISBN 9781421415406**

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In an overdue introduction that spans the most prescient history of technology's intersections with education, Bill Ferster has brought an amiable, approachable overview to both practitioner and scholarly audiences. As a research professor in the Curry School of Education and the Director of Visualization for the Sciences, Humanities and Arts Technology Initiative at the University of Virginia, Ferster has a legacy of working in technology and education. His account is organized chronologically. Given that he avoids an explicit theoretical framework for interpreting the history and development of technology in teaching and learning, this is the most straightforward approach to take. Yet what results is a rather unchallenging presentation of this history, lacking in an overarching or illuminating perspective and leaving Ferster's voice feeling somewhat aloof. Nonetheless, such a detailed account spanning a rather complete timeline is a highly valuable introduction to and historical grounding of this exploding field of research and practice.

The first chapter lays out the landscape of educational technology and its various manifestations from 15th century hornbooks to 21st century big data. Grounding its development in theories like sociologist Everett Rogers' (1962) "diffusion of innovations" and Gordon Moore's (1965) law about exponential microprocessor advancement, Ferster admits to being cautiously optimistic about the role of technology in education. Perhaps most importantly, in this introduction he outlines the parameters he will be working within to tackle such an amorphous and dynamic topic by laying out his definition of a teaching machine. For Ferster, "a teaching machine is defined as a way to deliver instruction by using technology that marries content and pedagogy into a self-directed experience for a learner and which relies on minimal assistance from a live instructor" (p. 17). Curiously, the care with which this definition is constructed is undermined by Ferster's inability to contain his analysis within it.

Chapter 2 exposes just how un-innovative massively open online courses (MOOCs) and the majority of approaches to contemporary online learning are. In tracing the origination and development of the first correspondence courses in Chautauqua, NY, we see that much of e-learning today echoes the "economies of scale" approach that

has persistently been so attractive in educational technology. Producing lessons and/or recordings of the lectures of prominent professors from elite universities at a one-time fixed cost and distributing that experience would set off the eager hopes of educational entrepreneurs again and again. Ferster traces a variety of media experiments with education including film, radio, television, and finally the internet. In each of this chapter's examples, we are alerted to the potential for technology to revolutionize education that never comes to fruition. Ferster points to the didactic approach to teaching that undergirds each of these technologies as their common flaw. The inability to adapt to individual needs of various, distinct learners means that although these technologies scale quite well themselves, their ability to teach does not.

In Chapters 3 and 4, Ferster takes a turn away from the previous commercialized exploits to those more focused on educational and learning theory. Chapter 3, "Step by Step," focuses on the development of mechanical teaching machines, whereas Chapter 4, "Byte by Byte," shifts to early computing. Both of these chapters are historically rigorous and the most insightful of the text. B. F. Skinner's work is covered here, along with his early influences and resulting intellectual progeny. Ferster draws upon concomitant psychology and learning theory and makes their impacts apparent. The in-depth reviews of early computing from the 1960s through the 1990s are detailed enough to require focused attention, yet are succinct enough to keep the story moving.

Chapter 5 is the most compelling of the book and also where Ferster is no longer able to contain his account to his "teaching machine" definition. It feels as though the previous chapters are setting the stage for this, a scan of the current educational technology landscape. This is Ferster at his most skeptical, questioning both the motivations and implementations of technology's innovators. For instance, his account of Salman Khan and the namesake academy is striking in its intimacy and its critique. Further, although MOOCs are introduced as educational technology's redemptive hope in their early, Canadian incarnations, they are ultimately shown to be an appropriate segue for Ferster's address of the influence of venture capital. He holds quite a few punches when engaging with the influences of private investment and profiteering, alluding only to the mismatch of venture capital's need for quick turnaround and education's notoriously slow adoption of change. There is much more room for critique here, and yet Ferster's nods to these negative influences do help to round out this portrayal of the industry.

The concluding chapter makes big promises with its title, "Making Sense of Teaching Machines," but fails to deliver. The chapter works as a summary

of the aforementioned content without coming to unique conclusions. The bulk of the chapter does not present Ferster's own conclusions but rather uncritically recants Everett Rogers' (1962) diffusion theory, a widely adopted concept of how innovations spread over time through social systems. Relying on Rogers' five characteristics of innovations as "a time-tested framework" (p. 167) for understanding the spread of technology means that Ferster doesn't question whether or not the various innovations in educational technology actually offer improvements or opportunities that *should* be spread. What are the benefits of these new technologies, and for whom? The reader is left asking what Ferster's take is on technology in education; that is, what more beyond his cautious optimism?

Ultimately, Ferster comes across as something of a teaching machine apologist. In so doing, he leaves more than a few stones left unturned. Issues of differentiated learning, the unevenness of the distribution of technology in education along lines of class, race, and poverty are referenced only lightly. Ferster's claims of cautious optimism towards technology's role in education certainly are more optimistic than cautious. Though not made explicit, Ferster might very well be someone that Evgeny Morozov (2013) had in mind when he outlined his critique of technological solutionism. What are the alternatives? Where could this go? Where *should* it go?

Yet, Ferster's *Teaching Machines* does make a strong contribution to writing on education and technology, specifically with his deep engagement with historic developments. He builds upon other historic accounts while making insightful links among them. Obviously invoking the touchstone work of B. F. Skinner (1961), Ferster helps us to understand what led up to Skinner's work, like the early experiments and theories of Sidney Pressy (1926). We also see how Skinner's developments led to further work by Glaser (1965) and Kay (1972). Understanding the earlier manifestations of that work in correspondence, radio, and television technologies imparts a rich context for considering contemporary educational technologies. But this is not an educational technology textbook, nor is it a deeply theoretical investigation of the epistemological underpinnings of technology's intersections with education as in Selwyn's 2011 account. Promisingly, on the horizon is Watters' (forthcoming) synonymous book that will engage with similar content as Ferster, but within an explicitly critical framework.

This text is an attempt to present a concise and focused history of a topic that is increasingly hitting the headlines in both popular and academic venues. Ferster seems to be addressing popular audiences with light and affable quotes from the likes of Ralph Waldo Emerson (p. 8), Thomas Edison (p. 32), Yogi Berra (p. 123), and Mark Twain (p.174). Anyone who follows headlines related to academic technology will bring enough knowledge to this text to make it eminently approachable. The underlying pedagogical and psychological theories at work here are clearly explained by Ferster, as much as needed to trace the narrative. Academic audiences will appreciate his engagement with learning theory from the likes of Dewey and Piaget that influenced B. F. Skinner's widely known and controversial work, among others. It should be noted, however, that the text is generally underdeveloped in the academic-theoretical rigor required of scholars of teaching and learning. Yet the insights into cultural and political contexts of the development of an impressively wide range of educational technologies will be useful for many a scholar.

For those looking to understand a deeper, longer history of educational technology beyond headline-grabbing accounts of educational technology startups, as well as those interested in approachable introduction to the field or a systematic inventory of its developments, *Teaching Machines* is an eminently readable account. Ferster's crisp writing style, dotted with pop culture references and personal anecdotes, makes for brisk reading. Further, his thoroughly documented notes and detailed index also make this a useful springboard into deeper study. This historical approach to what is too often a field decontextualized from its own development opens the door to a richer understanding of educational technologies.

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