International Society of the Learning Sciences

Why Robots?: Historicizing Engineered Imaginaries and Coded Visions of Learning

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Abstract: The inclusion of robots, robotics kits, and other automated tools and apps in educational settings leads us to consider hidden assumptions and implicit theories that robots encode. This paper draws critical attention to advances in automation by examining two current uses of robots in learning designs. Drawing on recent ideas in STS (Suchman, 2011) and Critical Code Studies (Benjamin, 2019), we analyze two categories of automated agents- competitive robots built by youth and coding robots used by young children.

One way of reflecting on the past and recalling the history of the learning sciences is through the field's origins in cognitive science and computing. Learning sciences inherited theories of learning from cognitive science's computational model of the mind as an information processor (Collins et al., 1978). Likewise, computer scientists and engineers have applied models of human intelligence to machines to develop devices that learn or that automate learning (Hayles, 2005). These mutual processes of designing learning and designing technologies have built automation and AI into the mainframe of our field. A consequence of the close relationship between learning sciences and robotics is that automation is accepted, well, automatically. This paper explores the questions: *why robots here, in education?* And *why robots, now at this particular historical moment?* Drawing on STS perspectives (Suchman, 2011) and recent advances in Critical Code Studies (Benjamin, 2019), we focus on two types of robots used in learning environments: *competitive robots*, which are built by students and used in robotics competitions and commercially available *coding robots* used to teach programming to young children.

Engineered imaginaries and coded visions of learning

All technologies encode human values, a point that is not lost on STS scholars (Suchman, 2011), but has yet to make it into the mainstream concerns of critically minded scholars of educational technology. While there have been some attempts to open the black boxes of learning technologies (e.g. Lachney & Foster, 2020), there is still much work to do to make AI more transparent for learners and to make visible how inequity gets encoded. If, as Benjamin (2020) incisively said, "most people have been forced to live in somebody else's imagination", how then are robots implicated in engineering inequitable imaginaries? And how are educational settings reproducing the "default settings", even as we design for learning that disrupts or resets established inequities? Robot designs are based in theories of human learning and behavior and often tested on young children, who have been model organisms for AI (Fox Keller, 2007). As robots and automated tools become regular fixtures in learning environments, it is important to consider what theories of learning and axiological assumptions they import and reproduce. As Firth and Robinson (2020) wrote, "there is also an element of futurology in mapping the field [of robot-human relations] because epistemologies prefigure technology creation" (p.12). Robot imaginaries mobilize future-oriented narratives of science fiction and speculative fantasy and animate utopian dreams of engineering a better future as well as dystopian notions of destruction (Richardson, 2015). We wonder what that means for education. Whose future does this help make?

Case 1: Coding robot toys

Coding robots respond to computer science standards and computational thinking frameworks that support learning to program for children as young as Kindergarten age (e.g. Silvis et al., 2020). Their cute construction and affordable price point make commercially available coding toys common features in today's early learning settings. The progenitor of these tools was Papert's (1980) tangible programming floor turtle, the literal embodiment of his "objects to think with," a "relational artifact" designed to support "epistemological pluralism" (Lachney & Foster, 2020). When such toys are used to teach computational thinking and other "21st century skills," we might wonder just what kinds of human-robot relations they support, what worlds they help to make, and what imaginaries they engineer and reproduce. We get some sense of these relations from Evelyn Fox Keller (2007) in "Booting Up Baby," where she describes the recursive reliance of children on robots and robots on children when it comes to thinking computationally. "For whom" and "to what ends" are good questions to ask about these designs and the futures they inspire (Philip et al., 2018). Designers of learning and technology should

also recall "from whom" these designs originate and "on whom" they are modeled. Whose babies are we booting up when we bring robots into early learning environments? Who is now being asked to live in those imaginations?

Case 2: Cooperative-competitive robots

Robotics competitions have dramatically increased over the past 20 years across the K-12 educational landscape. FIRST Robotics is a leader in managing and organizing youth robotics competitions, with divisions that span PreK to high school-aged children (FIRST Robotics, 2020). The logic of these competitions has epistemological foundations in constructivism (Lachney & Foster, 2020). Individual teams cooperate to engineer robots with a weight limit of 120 pounds that compete in the highest division. Robot designs are constrained by competition rules, which are remade and unveiled at the beginning of each year. Starting with the competition in mind means that the robot is always under construction over the course of the season. The final robot is therefore a dynamic collective imaginary of the team of youth, mentors, and coaches. For the majority of youth, the robot itself is not the learning technology; rather the team's iterative use of tools, machines, design software and programming ultimately make the robot operate. The robot is a symbolic vision of the relationships between humans and machines (Richardson (2011). Competitions are enmeshed with complex spatial politics around gender and race (Hennessy Elliott, 2020) and relatedly class, as certain teams obviously spend more money on their operations than others. We wonder what relationships emerge between the under-construction robot and the youth participants. What kinds of futures are robots helping to inhabit?

Discussion and significance

Benjamin's (2019) characterization of "the new Jim Code" cautions us to remain critical of how robots, as social and technological systems, might further encode future injustices. Whereas Suchman (2011) asked what figure of the Human is enacted in the design of humanoid robots, we wonder what futures are prefigured by engaging with robots in educational settings. In the case of coding robots, children are both the basis for and target of human-robot interactions. In the case of competitive robots, the robot is always under construction and the team is imagined as a collaborative community, where team culture is a means and outcome of design. Within each, there is also a hidden intent of educational designs that aligns: contributing to future industrial development as part of a skilled workforce which can program (coding robot and cooperative-competitive robot) and collaboratively design, engineer, and program mechanisms capable of addressing problems. We challenge educators and researchers to make opportunities with children and youth to critically engage with the histories of these educational designs and the futures- and learners- that they engineer and help us imagine.

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