PopBots: Leveraging Social Robots to Aid Early Childhood Artificial Intelligence Education

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1 Introduction

Artificial intelligence (AI) is revolutionizing society; changing how we live, work, and play. The greatest impact of this new technology will be on children, those growing up in a world of voice personal assistants, home robots, and Internet-connected smart toys. Our previous investigations into children's relationships with AI has shown that this population lacks an understanding of how AI devices work (Druga, Williams, Breazeal, & Resnick, 2017). Their incomprehension makes it difficult for them to engage in safe and constructive interactions with their playthings. Furthermore, as this technology becomes increasingly pervasive, we must think about how to use it to promote equity. By empowering the next generation of technologists with a creative AI curriculum, we hope to help AI become a tool that benefits all communities. In this paper, we explain our design of an early childhood AI curriculum and explore how children ages 4 to 6 learn with it. We also examine how children's perceptions of AI and self-identification as engineers are influenced after participating in the curriculum.

2 PopBot Curriculum

The Preschool Oriented Programming Curriculum, or PopBots, is the first robotic toolkit developed for young children to learn about AI. It includes a social robot learning companion embodied by a mobile phone and LEGO blocks, motors, and sensors. The social robot serves as both a programmable artifact and a guide that steps students through AI algorithms.

Figure 1: PopBot Components. The mobile phone and LEGO make up the robot. The tablet interface hosts AI activities and a programming interface.

In addition to the toolkit, we developed a hands-on, AI curriculum. The PopBots curriculum expands existing computational thinking curriculums by using creative learning activities to teach students three core AI concepts: knowledge-based systems, generative AI, and supervised machine learning. Knowledge-based systems were taught by having students train and program the robot to play rock, paper, scissors. Generative AI was accomplished by having students set pitch and tempo parameters to define musical emotions. Then, the robot would remix music in the

different emotional styles. Supervised machine learning was illustrated by having students develop training and test sets to teach the robot to differentiate healthy and unhealthy foods. In addition to the activities, we developed age-appropriate quantitative and qualitative assessments to evaluate children's understanding.

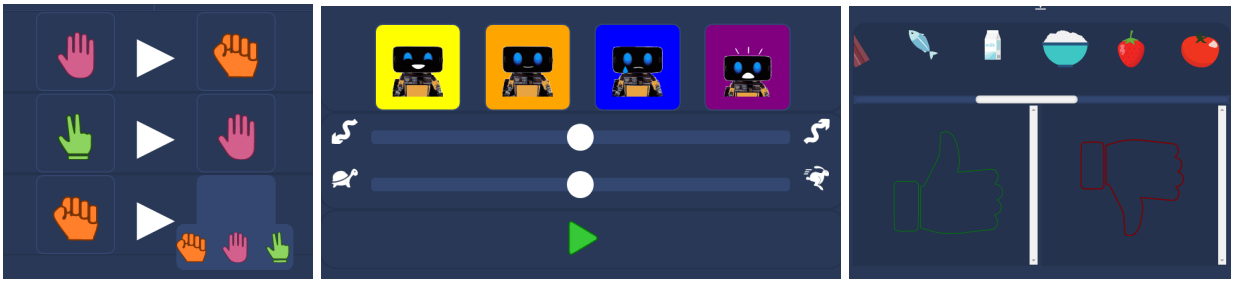

Figure 2: Screenshots of the three AI activities knowledge-based systems (rock, paper, scissors), generative AI (music remix), and supervised machine learning (food sorting).

3 Method

We evaluated the PopBots curriculum with 80 pre-K and Kindergarten children in four Boston-area schools. First, children completed an AI perception questionnaire, Engineering and Science Attitude questionnaire, and a Theory of Mind assessment. Then, children spent four sessions working through each of the PopBots activities and assessments. Finally, children repeated the pre-assessments.

4 Results

We found that the majority of the children understood the AI concepts as presented in the toolkit and related by the social robot artifact. Children performed best on the knowledge-based systems assessment, next best was supervised machine learning, and finally generative AI. Developmental factors like age and Theory of Mind skills often made a difference in what children understood. This suggests that a further improvement to this system would be more personalized to a child's developmental stage.

We also observed that children developed an understanding of robots as "learning beings." After teaching the robot themselves, they saw the robot as an object of dual nature: something that was alive, yet a machine and something that had a mind, but no independent motivations. Children were quite excited to continue to build their own robots, and felt confident in their ability to construct and program their own helpful, character-like robots. Children were highly engaged in the curriculum and, ultimately, came to see AI-based technology as something they can play a role in creating.

References

1. S. Druga*, R. Williams*, C. Breazeal, M. Resnick, "Hey Google is it OK if I eat you?": Initial Explorations in Child-Agent Interaction. In Proceedings of the 2017 Conference on Interaction Design and Children (IDC '17), 2017, ACM, New York, NY, USA, 595-600, https://doi.org/10.1145/3078072.3084330