Child-Robot Theater: STEAM Education in an Afterschool Program

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Abstract Children in an elementary school afterschool program utilizing the STEAM (science, technology, engineering, arts, and math) education paradigm created and acted in short plays with a variety of social robots.

CCS Concepts
• **Social and professional topics~Computer science education** • **Social and professional topics~Children** • *Applied computing~Performing arts*

Keywords
Human-robot interaction; child-robot interaction; STEAM education; live theater.

1. INTRODUCTION
With the increase of importance of the knowledge and skills to solve tough problems, gather and evaluate evidence, and make sense of information in this complex world, STEM education (science, technology, engineering, and math) was emphasized to provide cohesive learning paradigm based on real-world applications. While it is a good start, recently, arts and design have been added to traditional STEM education to allow students to comprehend the concepts in a more practical and creative way [1]. Our team at Michigan Technological University and the Great Explorations afterschool program of BHK Child Development put STEAM education concept into practice with a project combining robotics and theater. For educational goals, we wanted to familiarize the children with novel technologies, get them interacting with social robots, and create a memorable, positive experience that might pique their interest in computing, related sciences, and theater. For research, the goals were to investigate children's acceptance of social robots and the roles they allowed robots to take, particularly in group environments.

2. PROCEDURE
Over the course of nine weekly one hour sessions, participants in an afterschool program created two short plays that featured both the children and robots as actors. Since this was a voluntary program, the number of children varied week to week and it is not possible to give an accurate count of our participants. However, seven children answered demographics questionnaires, giving us 2 male and 4 female participants (one child declined to specify their gender) aged 5-7 years old. All children were students of Dollar Bay-Tamarack City Area Schools, where the study took place.

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Seven robots were used in the program: Darwin, Nao, Robosapien, Pleo, Zoomer, Romo, and BB-8. The program began with an introduction to robotics and our robots, along with a pre-questionnaire including the aforementioned demographic questions. We then discussed the elements of a fiction narrative. The children also created clay models of the robots for use as roleplaying devices while brainstorming story ideas. We then began creating original plots and scripts for two plays. One group created a space story and the other a treasure hunt tale. At the same time, basic programming concepts were described and reinforced with an active game. The following week the groups roleplayed their scripts and refined the stories. Using a variety of commonly available craft supplies, we created props and scenery for the plays including toy swords, a treasure map, and vegetables. While the robot parts had been assigned during the script writing process to accommodate the differing functionality of the robots, the children's parts were assigned after the scripts had been finalized. We rehearsed lines in read-throughs and full rehearsals on stage. Finally, the children performed the plays for their families. The week following the performance, part of the research team returned to administer a post-questionnaire.

3. RESULTS AND DISCUSSION
In both the pre- and post-questionnaires, children expressed interest in robotics generally. Staff at the school reported that students were excited to participate each week and continued discussing the program positively several months later. Four out of six students reported they made new friends during the program. Regarding acceptance of the robots, Nao (a humanoid) and Zoomer (robotic dog) were preferred over the other robots. We speculate that this preference was related to the friendly, cartoon-like appearance of the robots and their familiar shapes.

Acting in the play allowed the children to move and speak more than would have been feasible with a more sedentary art, which worked well for young energetic students. However, the memorization required for acting proved difficult. Having the children speak in chorus helped address this since the children could prompt each other. The students were more interested in the robots than in the plays, presumably at least in part because robots are more novel to these students.

We plan to continue working with underserved youths in our area and creating novel ways to combine the arts and sciences. We will teach children programming concepts through individual and team activities, and integrate various art forms in our child-robot interaction learning programs.

4. REFERENCES
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