

# Promoting STEAM Education and AI/Robot Ethics in a Child-Robot Theater Afterschool Program

AI/Robots Ethics in a Child Robot Theater Afterschool Program

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## ABSTRACT

A nine-week robot theater afterschool program was conducted in an elementary school to promote Science, Technology, Engineering, Arts, and Mathematics (STEAM) education using various Artificial Intelligence (AI) tools and social robots. In particular, the program aims to explore children's perceptions of the ethical implications of AI/robots in education. As a result, children showed excitement towards learning and interacting with AI/robots. Children's responses to ethical topics were also valuable as they expressed empathy towards robots and thought the developer should be responsible for negative situations, such as bullying. The present program will expand the knowledge of AI/robot ethics in early education.

## CCS CONCEPTS

•Social and professional topics~Professional topics~Computing education~Informal education •Social and professional topics~Professional topics ~Computing profession~Codes of ethics

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## KEYWORDS

Child-robot theater; AI/robot ethics; STEM; STEAM; human-robot interaction (HRI); Extracurricular program

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## 1 Introduction

Facilitating Science, Technology, Engineering, Arts, and Mathematics (STEAM) education in young learners is critical in enhancing their creativity, innovation, and problem-solving skills. With the rapid development of AI and robots, many schools have implemented computer science-related activities for students [2,9,15]. Social robots were also used in afterschool classes to engage students' learning and curiosity in STEAM education [1,3]. Considering the ethical aspects of using AI and robots in education is also crucial to prepare young learners with the concept of a coexistence world with advanced technologies while being inspired in STEAM-related career paths. Previous studies have investigated different macro and micro-ethical topics of AI/robots in various contexts: macro-ethical topics include equity and bias [4,7], data security and safety [5], morality and

responsibility [6], replacement of humans[16], and sustainability, and the micro-ethical topics include individual relationships, abuse of technology [12], integrity [11], bribery [14], disobedience, technology addiction, and emotional development [13]). However, few research studies have investigated the ethical implications of introducing AI/robots in early education. We conducted a nine-week robot theater afterschool program at a local elementary school incorporating STEAM (STEM with art elements) education, focusing on AI/robot ethics. The present robot-theater program aims to **1) promote STEAM education in the young generation using AI/robots, 2) investigate the program's impact on students' perspectives of AI/robots' ethical implications, and 3) enhance students' interests in STEAM and support their learning using AI tools and robots.**

## 2 Method

### 2.1 Participants

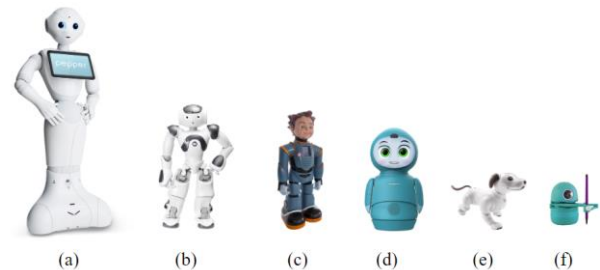
A total of thirty elementary students participated in at least one session of the multi-week afterschool program (16 females, 14 males). Participants' ages ranged from 5.42 to 11.92 years old ( $M = 8.04$  years,  $SD = 1.79$ ). The elementary school was identified as a Title 1 local elementary school with low-income students according to the Center for Educational Networks and Impacts (CENI) at Virginia Tech, the superintendent, and the Virginia Boys and Girls program. Child assent and parent consent were collected for each participant. Other children, without consent forms, were still allowed to join the program without participating in research activities.

### 2.1 Procedure

The 9-week robot theater afterschool program employed a pretest-posttest within-subject study. Those nine weeks included an introduction week and eight weeks of module sessions. The parents' consent forms and child assent forms were collected by the program coordinator before the start of the program. The pre-program survey and interviews were conducted in the introduction week, and the post-program survey and interviews were conducted in the post-visit week following the final performance, which was not included in the program. The survey items were related to interest in STEM, perceptions of AI/robots regarding their affective experiences, perceptual abilities, physiological sensations, agentic capacities, and social abilities [17]. The interview questions included students' perspectives regarding five ethical items (fairness, transparency, non-maleficence, privacy, and responsibility) [8], and cognitive and affective trust [10] of AI/robots.

The afterschool program consisted of four modules: Acting, Dancing, Music and Sounds, and Drawing. Those modules provided students with different aspects of STEAM education using AI and robots (Table 1). Six robots were involved in the afterschool program: Pepper, NAO, Milo, Moxie, and Quincy (Figure 1). A few other robot toys were also available for children to explore and play around with. NAO served as a teacher

assistant in each module as it was programmed to introduce and explain some of the STEAM contents in the module plan. In addition, we created a total of four videos regarding macro (accessibility and socio-economic status) and micro ethics issues (technology addiction and bullying). The six robots were mostly the main characters in those videos to analogize real-world ethical issues in a child-friendly way. One of the four videos was played to the students in each module to facilitate discussions on the ethics topic. After watching the video, one of the researchers presented questions about the video's ethical topic to the students. Each session of the modules lasted one hour per week, including learning activities (30 minutes) and free-play time (30 minutes) for students.



**Figure 1.** (a) Pepper, (b) NAO, (c) Milo, (d), Moxie, (e) Aibo, and (f) Quincy

**Table 1.** Program schedules.

Weeks	Modules	STEAM contents	Activities
1		Introduction to AI/robots (robot types and functions); Introduction to the social robots used in the program	AI/robot demos
2-3	Acting	Anthropomorphism (robot appearance and embodiment, emotions, morals, and cognition), robot speech, robot facial expressions	Programming (robot speech and facial expression)
4-5	Dancing	Physics (robot physical characteristics and constraints)	Programming (robot movements)
6-7	Music & Sounds	AI/robot voice, AI music composition	Music composition using AI tools
8	Drawing	AI/robot arts	Drawing with robots and AI tools
9		The final performance with robots	Recite lines and act in a theater play with robots

## 3 Results and Potential Impacts

The present program successfully increased children's interest and enhanced their learning in STEAM from our observations during the afterschool sessions. First, children were excited to see

robots and would recognize each robot's name even only after a couple of sessions (e.g., "The robots are here!" and "Look! It's Pepper!). Second, children could recall lessons learned after attending the Acting and Dancing modules. For example, students acknowledged the robots' physical limitations, such as weight and balance, and instructed other children to be "gentle" when interacting with robots (e.g., "You have to be gentle with NAO because it will fall" and "Give Pepper some space to move"). Some students showed interest in learning how robots worked and programmed NAO and Milo to control their behaviors and speech with researchers' assistance. In addition, students were engaged with using AI Duet to create piano music and Microsoft Image Creator from Microsoft Designer to prompt images as they continued to use these AI tools even in their free-play time. Finally, students developed emotional relationships with robots used in the program as they wanted to make friends with robots or show empathy to robots. A group of students surrounded Aibo to show affection, such as petting and hugging. One of the students asked the group to be quiet as Aibo was "sleeping". These observations supported our research objectives in facilitating an effective robot-theater program using AI/robots that enhance students' learning and interest in STEAM.

Regarding students' perspectives on the macro- and micro-ethical topics, their responses to the questions after watching each ethics video were worth noting. Before discussing ethics, we ensured that children were fully aware of the stories in the videos by asking them to describe the scenarios. Students were able to clearly understand the video contents and recognize the roles played by each robot. Next, we asked students to express their feelings after watching the video. Most students showed empathy toward the characters who were on the disadvantaged side; for instance, students mentioned that the robot/character felt "left out," "sad," and "lonely." Many students even shared their personal experiences that resonated with robots' feelings in the video with the class. Interestingly, students thought that the "person" or the "programmers" were mostly responsible for the villain robots' actions but not the robot itself. When asked whether they should be nice to a robot, students stated that "if you are nice to a robot, it will be nice to you back," "if you are nice to a robot, you get to play with them," and "it is not okay to be mean to the robots." These students' responses might state that the present afterschool program inspired young learners to consider ethical topics and enhanced their understanding of AI/robot ethics. After collecting all data, children's survey and interview results will be analyzed further to understand their subjective perceptions of AI/robots and their perspectives on AI/robot ethics. The video and audio recordings of children's responses collected after each video will also be analyzed qualitatively to support their interview answers in AI/robot ethics.

The outcomes of the present study will bridge the research gap in AI/robot ethics in early education. We hope that this study will inspire other researchers and practitioners to investigate the impact of different ethical factors on young learners' perceptions and opinions of AI/robots. The present program will also prepare the young generation for the coexistence of human and advanced

technologies by providing this unique learning opportunity with AI tools and robots.

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