

CHILD-ROBOT MUSICAL THEATER FOR INFORMAL STEAM EDUCATION



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INTRODUCTION

“Computer science for all” and “robotics for all” efforts

- A ***cohesive learning paradigm*** for STEM (Science, Technology, Engineering, and Mathematics)
- ***Real-world applications***

Major challenges remain in

- ***Finding diverse and flexible approaches and resources*** for robotics education for young learners (Belpaeme et al., 2018)

QUESTION (TEAM)

Can we combine interactive robots with theater arts to support children's interest and engagement in STEAM?



Myounghoon Jeon
ISE/CS



Ariana Wyatt
Performing Arts



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ICAT



Koeun Choi
Human Development

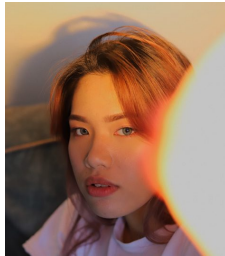


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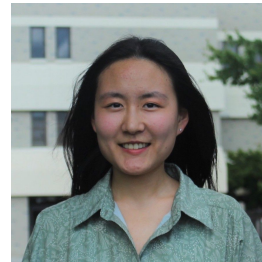
TEAM (CONT.)



Jia Dong



Jisun Kim



Shuqi Yu



Yeaji Lee



Devanshu, Irfath, Taylor, Martha, Breanne, Michelle

SPECIFIC AIMS

Aim 1:

- We designed a 13-week long afterschool program to connect ***child friendly robots (humanoid and animal robots)*** and ***familiar arts formats (arts, music, dance, drawing)*** to engage young learners.

Aim 2:

- Further, we conducted a research study to examine the effects of the program on children's thoughts and feelings about the ***program, robots, and STEAM*** (Science, Technology, Engineering, Arts, and Mathematics)

PROGRAM DEVELOPMENT

Child-Robot Musical Theater Afterschool Program

Goal:

- Promote children's *interest, curiosity, and confidence in STEAM* and robots.
- Help children exercise creativity and have fun while learning about robots in an informal setting.

Format:

- A 13-week modular program
- Four 2-week modules & performance
- Educational activities (30 min) & supervised free play (30 min)

Module	
1	Acting
2	Dancing
3	Sound/Music
4	Drawing
	Performance

With Social Robots

Child-Robot Musical Theater Afterschool Program

Story:



The Wizard of Oz

Robots:

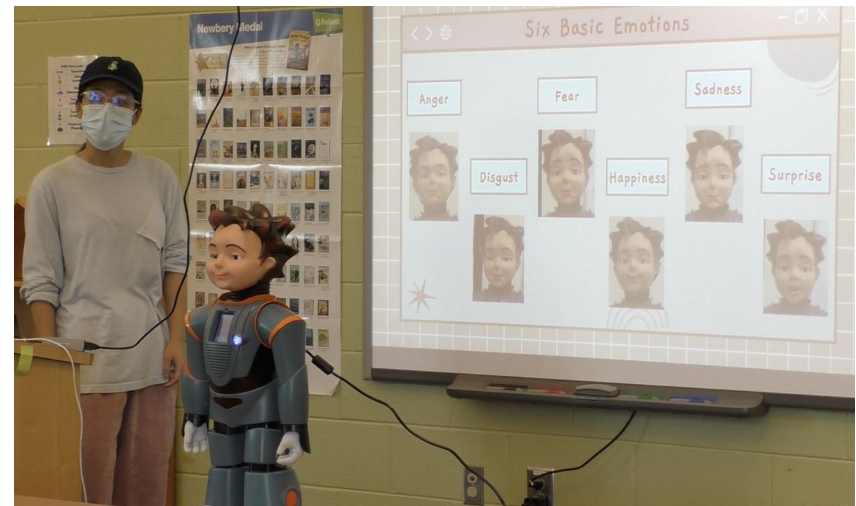


Social robots used in the program (Clockwise: Nao, Pepper, Milo, Quincey, Aibo, and Pleo)

Module 1: Acting

Learning Objectives:

- Compare and contrast the characteristics of robots in terms of anthropomorphism (superficial: appearance and behavior; essential: cognition, emotion, and morality)
- Practice how to control robot motions and speech for acting (remote, programming, verbal commands, and autonomous decision making).



Module 2: Dancing

Learning Objectives:

- Describe the characteristics of robots in terms of weight, balance, physicality, finer points of robot motion
- Apply different ways (autonomous and non-autonomous) to create robot motions for dancing



Module 3: Music and Sound

Learning Objectives:

- Discuss the fundamentals of generating music and sound based on emotion and gestures using robots, AI, and synthesizer
- Create sounds based on mappings with robots



Module 4: Drawing

Learning Objectives:

- Recognize drawing and design involving robots
- Create drawings and costumes to be used in children's child-robot musical theater performance.



Performance



Child-Robot Musical Theater Afterschool Program

Procedure:

Week	Topic	Educational Activities	Research
1	Pre Visit	Testing robots	Child survey & interview (pre) Teacher interview (pre)
2	Introduction	Intro to the program & team	
3,4	Module 1	Acting	Child module survey (1)
5,6	Module 2	Dancing	Child module survey (2)
7,8	Module 3	Sound/Music	Child module survey (3) Teacher interview (mid)
9,10	Module 4	Drawing	Child module survey (4)
11	Performance	Rehearsal & Performance	
12	Post Visit		Child survey & interview (post)
13	Wrap Up		Teacher interview (post)

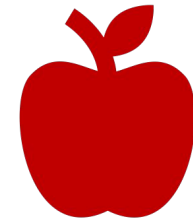
RESEARCH



Research Method

Participants:

- A sample of 16 children (8-10 years; 37% girls) from a Title 1 elementary school (with a high proportion of low-income students) participated in the program.
- Eleven of them (11 out of 16, 69% participation rate; 45% female) consented and participated in research.



Schedule:

- Fall 2021 (September – December)
- 4:30pm - 5:30pm



Child-Robot Musical Theater Afterschool Program

Setting:

- Empty rooms (library, gym) in the elementary school building.



Research Method: Child Module Survey (5 min; Per Module)

Procedure:

Week	Topic	Educational Activities	Research
1	Pre Visit	Testing robots	Child survey & interview (pre) Teacher interview (pre)
2	Introduction	Intro to the program & team	
3,4	Module 1	Acting	Child module survey (1)
5,6	Module 2	Dancing	Child module survey (2)
7,8	Module 3	Sound/Music	Child module survey (3) Teacher interview (mid)
9,10	Module 4	Drawing	Child module survey (4)
11	Performance	Rehearsal & Performance	
12	Post Visit		Child survey & interview (post)
13	Wrap Up		Teacher interview (post)

Research Method:

Child Survey & Interview (30 min; Pre, Post)

Procedure:

Week	Topic	Educational Activities	Research
1	Pre Visit	Testing robots	Child survey & interview (pre) Teacher interview (pre)
2	Introduction	Intro to the program & team	
3,4	Module 1	Acting	Child module survey (1)
5,6	Module 2	Dancing	Child module survey (2)
7,8	Module 3	Sound/Music	Child module survey (3) Teacher interview (mid)
9,10	Module 4	Drawing	Child module survey (4)
11	Performance	Rehearsal & Performance	
12	Post Visit		Child survey & interview (post)
13	Wrap Up		Teacher interview (post)

Research Method: Teacher Interview (15 min; Pre, Mid, Post)

Procedure:

Week	Topic	Educational Activities	Research
1	Pre Visit	Testing robots	Child survey & interview (pre) Teacher interview (pre)
2	Introduction	Intro to the program & team	
3,4	Module 1	Acting	Child module survey (1)
5,6	Module 2	Dancing	Child module survey (2)
7,8	Module 3	Sound/Music	Child module survey (3) Teacher interview (mid)
9,10	Module 4	Drawing	Child module survey (4)
11	Performance	Rehearsal & Performance	
12	Post Visit		Child survey & interview (post)
13	Wrap Up		Teacher interview (post)

Measures (Module Survey, Interview)

Engagement:

- Engagement in Science Learning Activities (Chung et al., 2016)
 - 8 items, 4 response options (1=NO!, 2=no, 3=yes, 4=YES!)
 - Examples
 - *During this activity: I felt excited.*
 - *During this activity: Time went by quickly.*

Sufficient Time:

- *During this module: I felt I got enough time with the robots/technology.*

Child and Teacher Interview Responses:

- A thematic analysis was performed for the child (pre, post) and teacher interview (pre, mid, post) data.

Measures (Pre/Post Survey)

Interest:

- *I am more interested in science, technology, engineering, and/or math than I was before attending the afterschool program.*
- *I am more interested in the arts than I was before attending the afterschool program.*

Curiosity:

Adapted from Fascination in Science
(Chung et al., 2016)

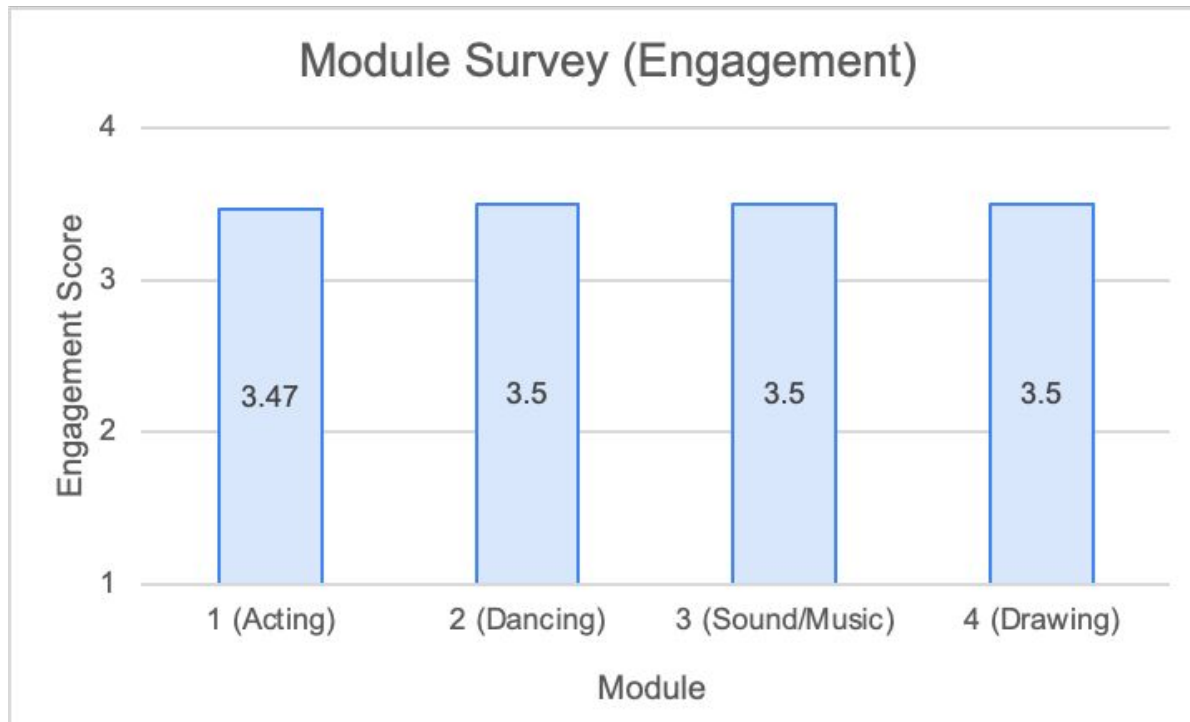
- 8 items, 4 response options (1=NO!, 2=no, 3=yes, 4=YES!)
- Examples
 - *I wonder about how **robots** work.*
 - *After a really interesting activity with **robots** is over, I look for more information about it.*

Competency Beliefs:

Competency Beliefs in Science (Chung et al., 2016)

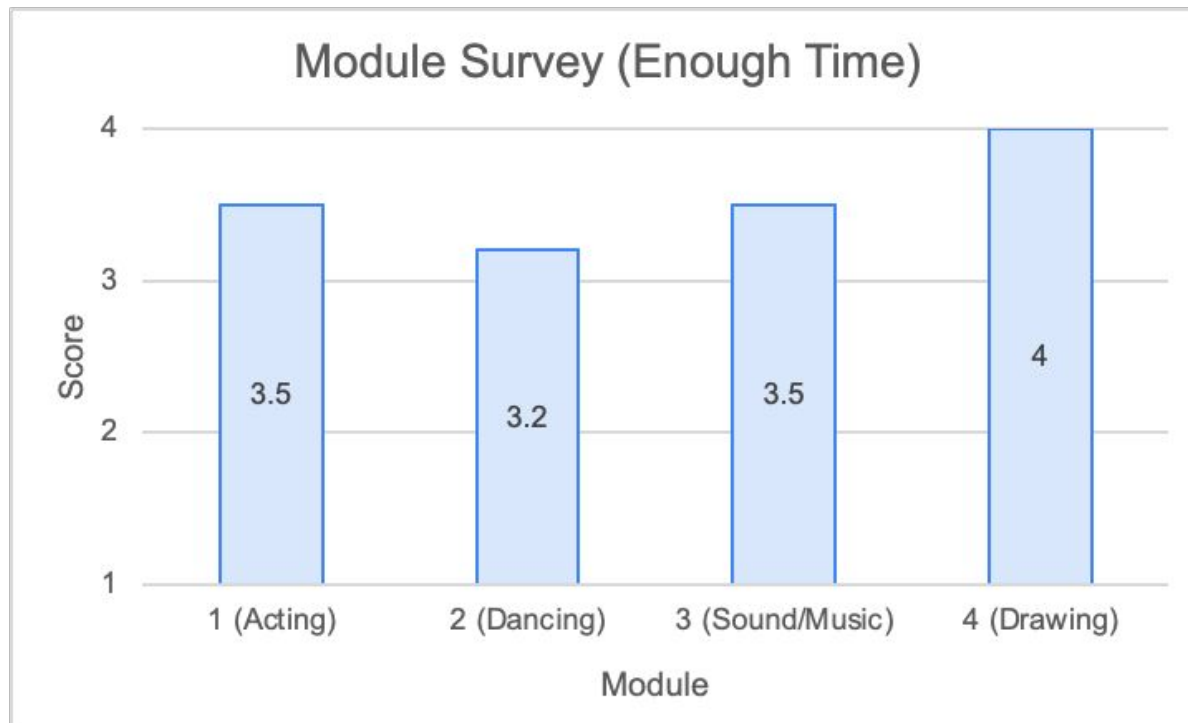
- 8 items, 4 response options (1=NO!, 2=no, 3=yes, 4=YES!)
- Examples
 - *I think I am very good at: Coming up with questions about science.*
 - *I think I am very good at: Doing experiments.*

Engagement



- Children reported a high level of engagement throughout the program ($M = 3.5$ out of 4).

Sufficient Time



- Children judged that they had enough time with robots and technology overall with some variability (lowest: dancing, highest: drawing).

Interest, Curiosity, and Competency Beliefs in STEAM

Interest in STEAM:

- Following the program, all children reported increased interest in STEAM (100%).

Curiosity in robots:

- Children's curiosity in robots ($M_{pre} = 3.7$, $M_{post} = 3.6$; out of 4) was high both pre- and post-program.

Competency Beliefs in STEM:

- Children's competency beliefs in STEM ($M_{pre} = 3.02$, $M_{post} = 3.09$; out of 4) was high both pre- and post-program.

Themes and Interpretations

Enthusiasm about social robots:

- *Children and teachers expressed interests in social robots and held positive attitudes towards social robots.*

Human robot interaction advantages:

- *Children and teachers discussed specific ways that humans can utilize robots to make their lives better.*

Anthropomorphism:

- *Children and teachers mentioned human-like characteristics of the social robots.*

Robot design and mechanisms:

- *Children and teachers described the design and mechanisms of social robots using scientific and technical terms.*

Conclusions

- The findings suggest that our program effectively maintained children's engagement and improved their interest in STEAM.
- Further research is needed to increase sample size, consider ways to enhance children's curiosity and competence beliefs, and take into account children's demographic diversity.

Future Directions – Preschoolers

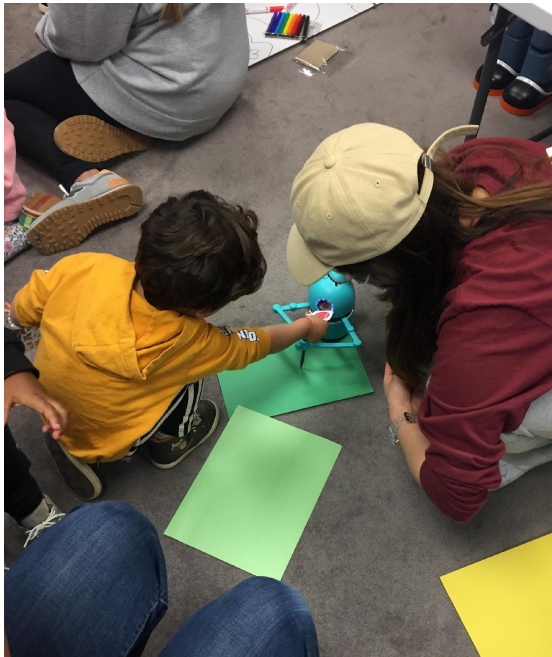
- **Our current work:** A child-robot theater program for preschoolers to promote STEAM learning in an early childhood education setting.



Future Directions – Preschoolers (Cont.)



Future Directions – Preschoolers (Cont.)



Future Directions – Immersive Theater

Our current work:

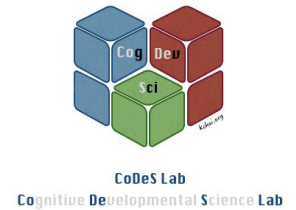
Robot Musical Cube Theater, featuring social robots telling stories involving an educational lesson in immersive environments (w/ visualization, motion tracking, and immersive 3-D audio).



Future Directions – Measure, Program, Tech

- We are working on developing systematic ways of measuring children's engagement during large group activities.
- Future research will focus on the development and evaluation of
 - (1) a supplemental program that involves more affordable robots and
 - (2) assistive robot control technologies for young children, parents, and teachers.

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Collaborators

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- Chelsea Lyles, Phyllis Newbill, *Center for Educational Networks and Impacts, VT*
- Tanner Upthegrove, *Institute for Creativity, Arts, and Technology, VT*
- Ariana Wyatt, *Performing Arts, VT*

Cognitive and Developmental Science (CoDeS) Lab

- Undergraduate Research Assistants
- Jisun Kim, Graduate Student
- Shuqi Yu, Graduate Student

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Participating children, families, teachers,
and schools!



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