The relation of museum visitors' collaboration approaches and engineering engagement during a community design puppet-making activity

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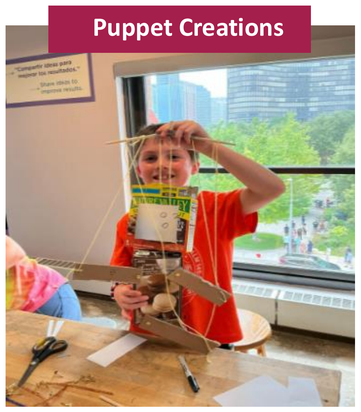
INTRODUCTION

- Makerspaces are informal learning environments providing opportunities for children and their families to engage in rich collaborative STEM processes (Pagano et al., 2020).
- Characteristic to makerspaces, engineering practices (e.g., planning, problem solving, collaboration) are essential to everyday tasks and various STEM careers (Bevan et al., 2015, NGSS Lead States, 2013).
- Collaboration (e.g., sharing ideas and helping one another) can support children's learning during tinkering activities (Aldrich & Haden, 2024).
- **We investigated how children and their caregivers' framing of ideas during a tinkering activity relates to their overall engagement in the engineering design process.**

METHODS

Puppet Creations



- **Participants:** 39 caregiver-child dyads
  - Children 4-10- years-old (*M*age = 6.63; 19 girls)
  - 43.9% White, 12.2% Black, 2.4% Asian, 4.9% Hispanic/Latinx, 24.4% Mixed, 12.2% Unreported
- **Program:** Tinkering activity at a children's museum – dyads constructed (a) a puppet that has movement and (b) a story behind their creation.
- **Coding:** 30sec time sampling coding of dyad engineering design process talk during tinkering, and categorization of "exchanging ideas" dialogue to capture families' idea framing approaches.

Engineering Design Process Coding

Code	Definition
Setting Goals	Asking questions to elicit a goal or plan what they want to make.
User-Centered Design	Referencing the goals, needs, or experiences of a character, person, or community.
Constructing/ Referencing Models	Referencing/comparing/contrasting with other examples.
Making Predictions	Predicting something will or will not work.
Collaboration	Offering/asking for help, talk about working together.
Testing	Verbal and nonverbal testing of their creation or its parts.
Identifying Problems	Talking about things not working, identifying problems during a test or trials.
Identifying Solutions	Redoing something based on something not working or fixing issues after testing.
Function of Tools and Materials	Talking about the function of the tools/materials they are using.

Idea Framing Approaches Coding

Code	Definition
Individual	Statements that indicate individual action or thought regarding what to do next ("First, I need to cut this out").
Group	Statements or questions that indicate collective/group-oriented action or thought ("Let's get a bigger piece").
Other	Giving each other directions/suggestions or asking questions regarding what to do next or how the other person can assist ("You could use the hot glue gun") ("Where do you want it?").

RESULTS

- Families frequently engaged in engineering design process (EDP) talk during the activity: Caregiver Total EDP talk (*M* = 22.82, *SD* = 12.55), Child Total EDP Talk (*M* = 20.21, *SD* = 10.98).
- The average time spent tinkering was 0:41:51 (*SD* = 0:17:00).

Table 1. *Hierarchical Regression Analysis Examining* ***Children's*** *EDP Talk*

Variable	Model 1			Model 2			Model 3		
	B	SE B	β	B	SE B	β	B	SE B	β
Constant	16.78***	4.59		9.95	5.23		6.78	4.43	
Number of Time Intervals	.04	.05	.13	.04	.05	.11	-.02	.05	-.07
Caregiver Total EDP Talk				.32*	.14	.36	.07	.12	.09
Individual-Centered Ideas							.34	.23	.25
Group-Centered Ideas							.83*	.38	.29
Other-Centered Ideas							2.65**	.91	.42
	R^2	F	ΔR^2	R^2	F	ΔR^2	R^2	F	ΔR^2
	.02	.65	.02	.15	3.11	.13	.50	6.47***	.35

Note. N = 39. *p < .05. **p < .01. ***p < .001.

- Children's idea framing approach accounted for 50% of the variance in their EDP talk during tinkering.
- Strongest predictors: framing ideas as other-centered and group-centered.
- Individual-centered ideas did not predict their EDP talk.

Table 2. *Hierarchical Regression Analysis Examining* ***Caregiver's*** *EDP Talk*

Variable	Model 1			Model 2			Model 3		
	B	SE B	β	B	SE B	β	B	SE B	β
Constant	21.66***	5.29		14.63	5.83		4.98	4.25	
Number of Time Intervals	.01	.06	.04	-.003**	.06	-.01	-.04	.04	-.11
Child Total EDP Talk				.42*	.18	.37	.40**	.13	.35
Individual-Centered Ideas							.70	.48	.16
Group-Centered Ideas							.89***	.19	.54
Other-Centered Ideas							.31*	.14	.28
	R^2	F	ΔR^2	R^2	F	ΔR^2	R^2	F	ΔR^2
	.002	.06	.002	.13	2.77	.13	.64	11.52***	.50

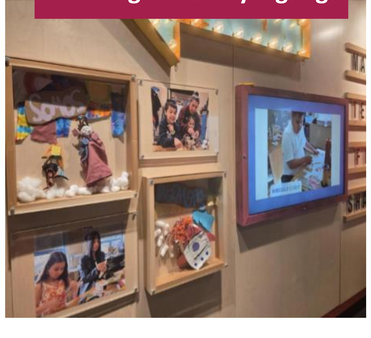
Note. N = 39. *p < .05. **p < .01. ***p < .001.

- Caregiver's idea framing approach accounted for 64% of the variance in their EDP talk during tinkering.
- Strongest predictors: framing ideas as group-centered and other-centered.
- Individual-centered ideas did not predict their EDP talk.

Conclusions

- When engaging in hands-on engineering activities together, sharing ideas and framing the work as a collective effort is associated with families' engagement in the EDP and may signal who engineering is for and who belongs in it.
- To support family learning, makerspace educators can integrate simple verbal invitations and reminders during activities that encourage visitors to work together collaboratively and share ideas as a group.

Tinkering Lab Entry Signage



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