Tinkering here and there: How families talk about informal STEM learning activities in museums and at home

Lauren C. Pagano, Riley E. George, Kaitlyn L. Hurka, Elena F. Fiegen, Evan J. Vlahandreas, Catherine A. Haden, David H. Uttal

Loyola University Chicago & Northwestern University

This material is based upon work supported by the National Science Foundation under Grant No. 1906839/1906940/1906808

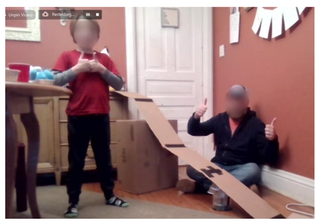
Thank you to Kim Koin, Tsivia Cohen, and Natalie Bortoli at Chicago Children's Museum for their work creating the tinkering activities.

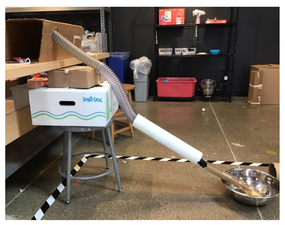
Introduction

- Tinkering activities can support family engagement and children's STEM learning in informal settings (Pagano et al., 2020; Marcus et al., 2021).
- Further, family engagement during informal learning can be supported by both the activity design and the physical design of the spaces (Geerdts et al., 2015; Gupta et al., 2019).
- We explored how families' (1) use of materials, (2) verbal engagement, (3) hands-on engagement, (4) engineering design process talk, and (5) spatial language differed when doing a tinkering activity at home or in a museum.

Participants & Method

- Families with children between the ages of 4-11- years- old (*M* = 6.91) participated in a tinkering activity in which they were asked to build a ramp to move a project from "here" to "there." After tinkering, the child was interviewed about their experience.
  - **Home** (*n* = 38): Families participated from their homes via Zoom, and a researcher showed a museum-created video introducing the activity.
  - **Museum** (*n* = 22): Families participated in Tinkering Lab, where a facilitator provided a verbal orientation to the activity.
- 59% of children were male and 41% were female.
- 52% Caucasian, 15% Asian, 11% Black, 11% Latine, 11% More than one





Category	Codes
Materials	From the video, we coded how many unique materials were included in families' final ramps (cardboard, plastic, metal, paper).
Families' Tinkering Interactions	
Verbal Engagement	In each 30-second interval, whether children and adults were speaking.
Hands-On Engagement	In each 30-second interval, whether children and adults were physically touching their projects.
Engineering Design Process	In each 30-second interval, whether families talked about setting goals, brainstorming, planning, testing, identifying problems, redesigning.
Children's Post-Tinkering Interviews	
Engineering Design Process	Frequency of talk about setting goals, brainstorming, planning, testing, identifying problems, redesigning.
Spatial Talk	Frequency of talk about Spatial Dimensions, Shapes, Locations/Directions, Orientations/Transformations, Continuous Amounts, Deictics, Spatial Features/Properties, Patterns (Cannon et al., 2007).

Results

Figure 1. Families' Material Use and Engineering Talk during Tinkering

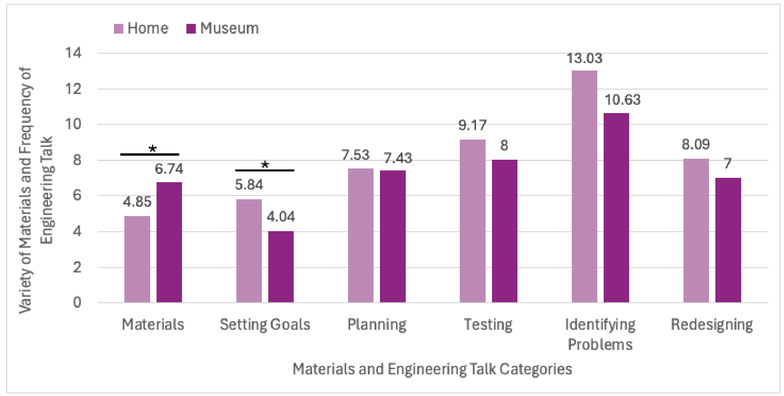


Figure 2. Families' Engagement during Tinkering

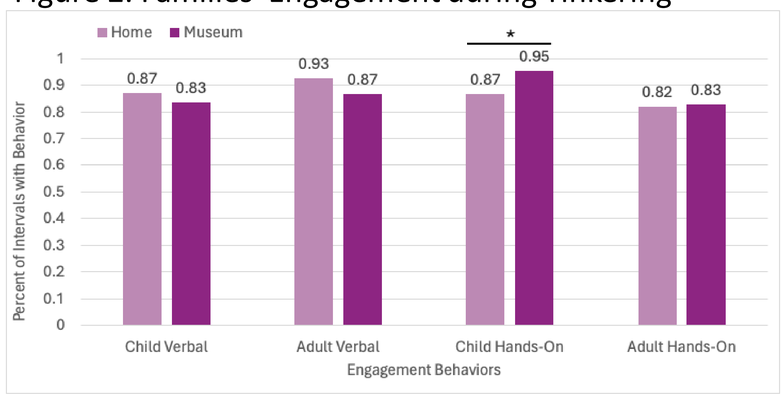


Figure 3. Children's Engineering Talk in Interviews

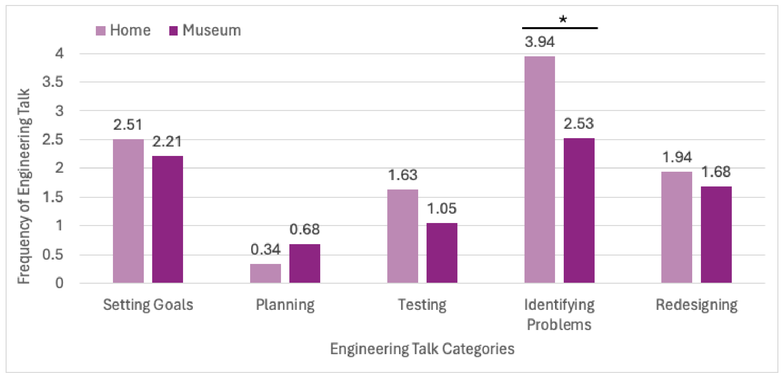
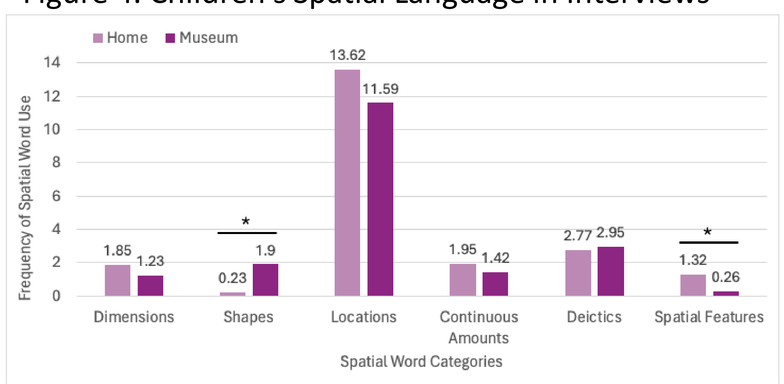


Figure 4. Children's Spatial Language in Interviews



- As shown in Figure 1, families used a greater variety of materials in the museum compared to at home, $F(1, 54) = 13.45$, $p < .001$.
- Families engaged in more goal-setting during tinkering if they were at home, compared to if they were at the museum, $F(1, 54) = 7.41$, $p = .009$ (see Figure 1).
- As shown in Figure 2, children were significantly more hands-on at the museum, compared to at home, $F(1, 57) = 10.83$, $p = .002$.
- Children were more likely to talk about engineering problems in their post-tinkering interviews at home, compared to at the museum, $F(1, 52) = 4.19$, $p = .046$ (see Figure 3).
- As shown in Figure 4, children at the museum spoke significantly more about shapes than children at home, $F(1, 51) = 21.77$, $p < .001$.
- However, children at home spoke significantly more about spatial features than children at the museum, $F(1, 51) = 6.64$, $p = .013$.

Discussion

- Tinkering in both museums and in families' homes can provide rich opportunities for collaboration, engineering design, and spatial language use.
- However, museums offer families a wide range novel objects, which may be why their projects included more materials and children were more hands-on.
- At home, families may be familiar with their building materials, and are better able to set clear goals and identify problems.
- Museums may be able to expand STEM learning opportunities in their communities by sharing opportunities for at-home family learning online.