

# Story-based tinkering programs as engendering both a sense of belonging and spatial thinking in museums

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## INTRODUCTION

- Spatial skills are foundational to children's later STEM abilities and central to everyday practices (Newcombe et al., 2013).
- Storytelling can support children's processing of spatial and other complex STEM concepts during informal learning activities (Haden et al., 2023; George et al., 2026).
- Story-based framing that invites playful, personal connections may foster families' enjoyment and expressions of STEM belonging (i.e., the sense that one is welcomed, valued, a part of, and capable of STEM) (George et al., 2026; Pepler et al., 2022).
- **Aim:** With two story-based programs involving spatial problem-solving, we explored how children's expressions of belonging during tinkering might relate to their post-tinkering reflective storytelling and spatial talk.

## METHODS

- **Participants:** 66 families with 4-to 10-year-old children (35 girls; *Mage* = 6.79; 52% White) built a creation and engaged in reflective storytelling post-tinkering.
- **Programs:** Belonging was coded during two programs, Cardboard Neighborhood (*n* = 21) and Tiny Playground (*n* = 45)
- **Post-tinkering Reflection Coding:** Frequency of children's storytelling talk and spatial talk (Cannon et al., 2007).



| Post-Tinkering Spatial Talk  |                             |
|------------------------------|-----------------------------|
| Code                         | Examples                    |
| Spatial Dimensions           | Big, long, narrow, size     |
| Shapes                       | Circle, rectangle, cylinder |
| Locations/Directions         | From, under, left           |
| Orientations/Transformations | Turn, tilt                  |
| Continuous Amounts           | Part, more, room, inch      |
| Deictics                     | Here, there, wherever       |
| Spatial Features             | Side, curve, angle          |
| Patterns                     | Next, before, repeat        |

| Post-Tinkering Storytelling   |                |
|---|----------------|
| Framing the task through <b>fantasy/fiction</b> stories (e.g., characters, locations) or through real-life <b>past experiences</b> or activities (e.g., personal interests, own neighborhoods or parks) |                |
| Belonging During Tinkering  |                |
| Helpful to Others   | Interest       |
| Persistence   | Enjoyment      |
| Confidence  | Comfortability |
| Encouragement   | Connection     |
| Motivation  | STEM Identity  |

## RESULTS

**Table 1.** Frequency of Key Variables Across Programs

| Code                  | Cardboard Neighborhood | Tiny Playground        |
|-----------------------|------------------------|------------------------|
|                       | <i>M</i> ( <i>SD</i> ) | <i>M</i> ( <i>SD</i> ) |
| Storytelling Talk     | 7.24 (5.03)            | 9.11 (6.75)            |
| Belonging Expressions | 20.52 (11.30)          | 22.00 (8.83)           |
| Spatial Talk          | 12.70 (10.66)          | 16.04 (11.37)          |

- We did not find any differences in children's storytelling at reflection, expressions of belonging, or spatial talk at reflection by program, *ps* > .10.

**Table 2.** Hierarchical Regression Predicting Children's Post-Tinkering Spatial Talk

| Variable                    | Model 1               |          |                         | Model 2               |          |                         | Model 3               |          |                         |
|-----------------------------|-----------------------|----------|-------------------------|-----------------------|----------|-------------------------|-----------------------|----------|-------------------------|
|                             | B                     | SE B     | β                       | B                     | SE B     | β                       | B                     | SE B     | β                       |
| Constant                    | 7.54*                 | 3.42     |                         | 4.42                  | 2.95     |                         | 2.49                  | 2.96     |                         |
| Time                        | .004*                 | .001     | .30                     | .001                  | .001     | .10                     | -.001                 | .002     | -.11                    |
| Tinkering                   |                       |          |                         |                       |          |                         |                       |          |                         |
| Post-Tinkering Storytelling |                       |          |                         | .95***                | .19      | .56                     | .90***                | .18      | .54                     |
| Belonging During Tinkering  |                       |          |                         |                       |          |                         | .36*                  | .15      | .33                     |
|                             | <i>R</i> <sup>2</sup> | <i>F</i> | Δ <i>R</i> <sup>2</sup> | <i>R</i> <sup>2</sup> | <i>F</i> | Δ <i>R</i> <sup>2</sup> | <i>R</i> <sup>2</sup> | <i>F</i> | Δ <i>R</i> <sup>2</sup> |
|                             | .09                   | 5.98*    | .09                     | .37                   | 16.68*** | .27                     | .42                   | 13.85*** | .06                     |

Note. *N* = 66. \**p* < .05. \*\**p* < .01. \*\*\**p* < .001.

- As shown in Table 2, across programs, time spent and belonging during tinkering, and storytelling at reflection explained 42% of the variance in children's spatial talk at reflection.

## CONCLUSIONS

- Integrating simple program design features such as toy characters and providing prompts for storytelling can create children's positive affective engagement such as expressions of belonging during spatial challenges.
- Additionally, makerspaces afford opportunities for children to practice their spatial skills.
- Expanding upon these observational approaches, future work will explore children's personal reflections on how they felt during story-based tinkering programs.