

Reflecting on Tinkering: The Connection Between Engagement and STEM Learning

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INTRODUCTION

- Parent-child interactions in interactive informal settings, such as libraries or museums, can facilitate learning (Jant et al., 2014; Marcus et al., 2021).
- Open-ended, playful exploration such as tinkering, supports engineering skills like planning, testing, and redesigning (Wang et al., 2013).
- Emotions, particularly positive ones, have been shown to be conducive to learning, while negative ones are largely detrimental (Tan et al., 2023).
- We put forth the following hypotheses:
 - We predicted more emotional expression after educators revealed a new problem regarding families' projects.
 - We hypothesized that children with a greater proportion of positive activating emotion will exhibit more learning.

PARTICIPANTS

- Twenty-two families with children ages 6-10 years old ($M = 8.25$, $SD = 1.29$) were recruited from a tinkering program hosted at a library or museum.
 - Gender: 32% girls, 68% boys
 - Ethnicity: 47% white, 11% black, 26% Asian, 11% Hispanic, 5% more than one

METHODS

- Families participated in a tinkering program hosted by either a local library or a children's museum.
- Families were tasked with creating a slide using everyday materials such as cardboard and tape, for their riders (wooden balls) to move from the top of their table to the pool (shoebox on the floor).
- Once families were successful, a facilitator put a "monsters' nest" on their slide, obstructing their riders' path. This created a new problem for the families: to adjust their slide or create a new one that would not disrupt the monsters' nest.
- Families' tinkering conversations were coded for talk about emotions.
- **Post-Tinkering Interview:** After tinkering, a researcher interviewed the child about the activity, which was coded for STEM talk.

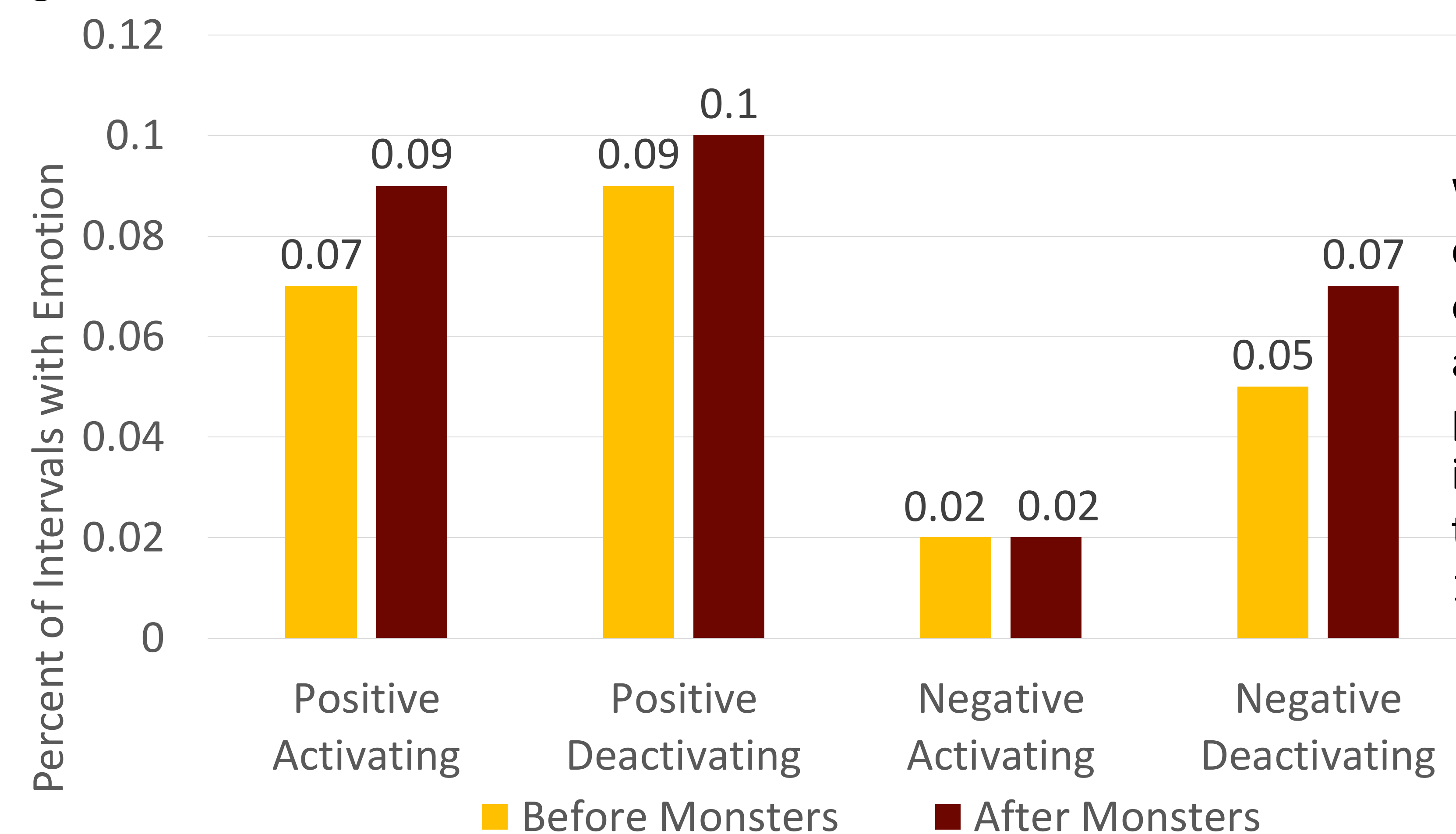


Emotion Code	Definition
Positive Activating	High arousal positive emotions (ex. Excitement)
Positive Deactivating	Low arousal positive emotions (ex. Contentment)
Negative Activating	High arousal negative emotions (ex. Crying)
Negative Deactivating	Low arousal negative emotions (ex. Boredom)

STEM Talk Code	Definition
Math	Reference to quantity, measurement or shapes
Association to Prior Knowledge	Connections to previous experiences or knowledge
Explanation/Prediction	Offering reasons for event or action
Evaluation	Talk about emotions regarding their project/ program
Engineering Design	Reference to sturdiness, balance, testing, etc.
Metacognitive	Reference to cognitive process (ex. Brainstorming)
Failure	Reference to failing or something not working

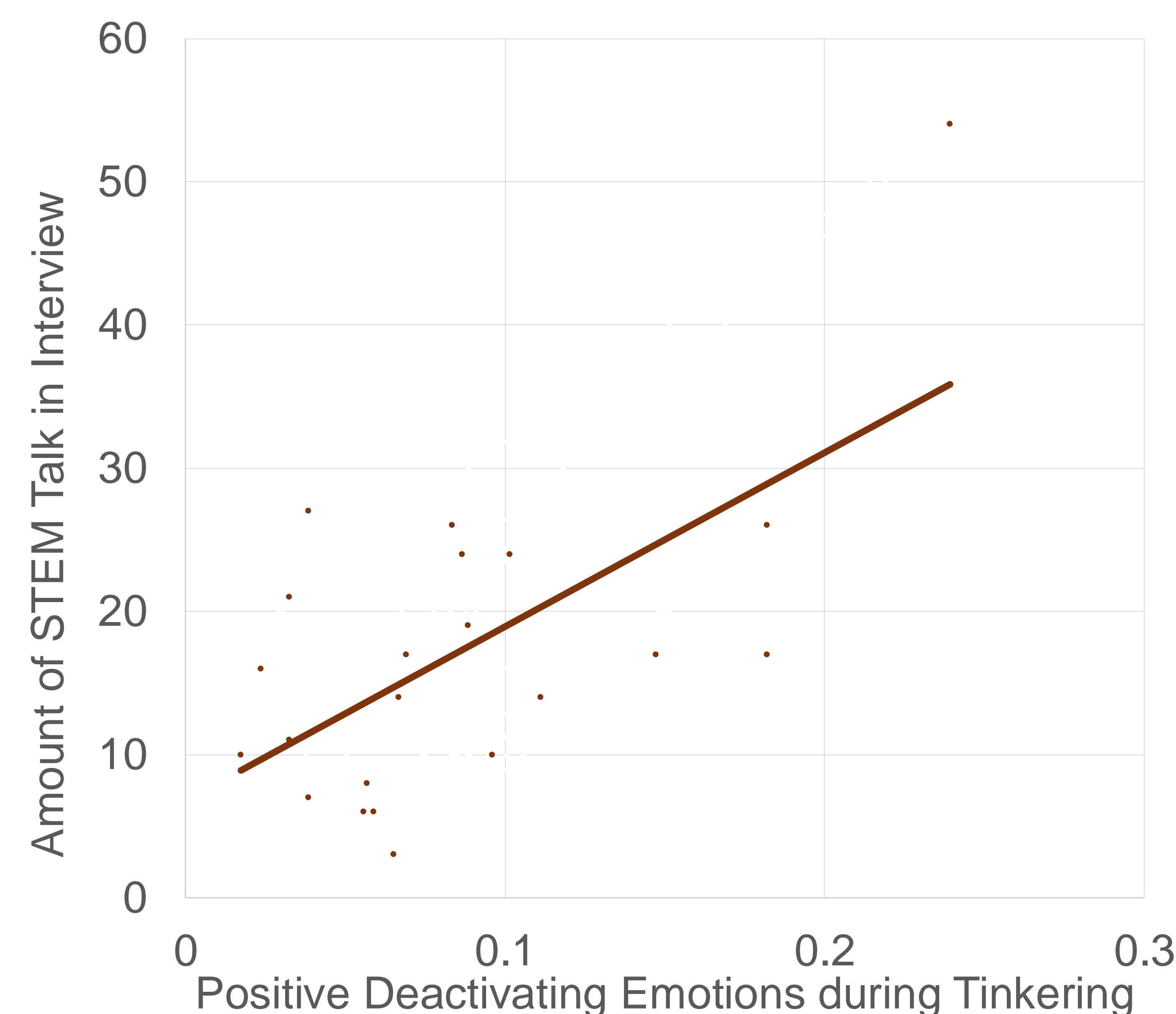
RESULTS

Figure 1. Children's Emotions Before and After Introduction of Monsters



We saw no changes in children's emotional expression before and after the monster nest problem was introduced during the tinkering activity, $F_s < 1.00$, $p_s > .33$.

Figure 2. Deactivating Emotions and STEM Talk in Post-Tinkering Interview



- Children's expression of positive deactivating emotions was correlated with several STEM talk variables, including:
 - *Engineering*, $r(22) = .591$, $p = .004$
 - *Explanations and Predictions*, $r(22) = .412$, $p = .057$
 - *Failure*, $r(22) = .710$, $p < .001$
 - *Metacognition*, $r(22) = .535$, $p = .01$
- No correlation was found between positive activating emotions or any negative emotions and STEM talk, $r_s < .295$, $p_s > .18$.

DISCUSSION

- Positive deactivating emotions (ex. contentment, satisfaction) during tinkering were significantly associated with children's STEM talk.
 - Such emotions may have supported STEM talk because they allowed the child to maintain a clear, focused headspace while tinkering, which would be important in their ability to later reflect on their STEM experiences (Rowe et al., 2023).
- Future research can explore how the quality of engagement and emotional expressions relate to STEM learning in informal settings.

ACKNOWLEDGMENTS

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