

## Background

- STEM major attrition is a pressing concern in the US.
  - 28% of bachelor's degree seeking students enter a STEM major, and nearly half (48%) leave their STEM major before graduation (Chen & Soldner, 2013).
- Out-of-school time (OST) STEM programs can prepare youth for their journey toward a STEM career (National Research Council, 2009).
  - Participation in OST STEM programs is linked to positive learning outcomes (Afterschool Alliance, 2011), but it is unclear how these programs positively affect youth.
- Learning-through-teaching (LTT) is effective in supporting youths' science learning in formal learning environments (McNeil, Lizotte, Krajcik, & Marx, 2006).
  - Less is known about the role of LTT in youth's science learning in OST learning environments.
- The purpose of the current study was to conduct an in-depth, qualitative exploration of the role of LTT in youths' science learning in an OST learning environment.

## Method

### Context

Participants were graduates of the Science Minors and Achievers (SMA) program. SMA is a science-focused, youth development program that takes place at the Museum of Science and Industry, Chicago. SMA is a free program and serves a diverse group of high school aged youth. LTT is a core part of the SMA program curriculum and takes the form of science presentation experiences for guests on the Museum floor.

### Participants

- 16 youth who graduated from the SMA program in June, 2017.
- 62.5% female; 37.5% male; 0% non-binary
  - 50% white; 31.25% African American/black; 18.75% Latinx; 12.5% Chinese; 6.25% Middle Eastern
  - 3 (18.75%) participants identified as multiracial

### Procedure

Semi-structured interviews (55-120 minutes) were completed during summer, 2017. The interviews were audio recorded and transcribed verbatim for analysis.

### Interview Protocol

Participants discussed their experiences in the SMA program, what they gained from participating in the program, and plans for the future.

### Data Analysis

Data analysis was guided by a two-phase, modified grounded theory process (Charmaz, 2006). In the **initial coding** phase, three researchers read each transcript, identified themes, and developed a coding framework. Then, in the **focused coding** phase, they confirmed the coding framework accurately reflected the data. The end result was a coding framework that revealed relations among LTT experiences and youth outcomes.

## Research Question

**How do learning-through-teaching experiences relate to youths' science learning in a science-focused, youth-development program?**

## Results

Learning-through-teaching experiences in the SMA program were related to the following science learning outcomes:

### Presentation and Communication Skills

Participant described an improved ability to conduct presentations and/or communicate, and/or identified particular presentation and/or communication skills that they developed as a result of their science presentation experiences.

*"There's a challenge because you never know who's going to come in to see your facilitation. It can be a kid who's four years old. It can be a person who is 80 years old. It can be a perfect English speaker. It can be a person who does not understand English at all. You have to take that extra step to really be knowledgeable in that subject so you can present to all people."* -Sofia

### Science Knowledge Construction

Participant described learning new science facts and/or increasing their understanding of science concepts as a result of their science presentation experiences.

*"They [science presentation experiences] helped reinforce what I learned in school and made me think about it in a new way. Once I had the opportunity to teach people about it, then I realized, "Oh, now I get it." Before I was just memorizing facts and repeating them, and now, I legitimately understand them."* -Lucy

### Increased Confidence

Participant described a feeling of increased confidence, including but not limited to, self-confidence, confidence in their ability to talk to people, confidence in their presentation skills, and/or confidence in their science knowledge as a result of their science presentation experiences.

*"I feel like I'm a lot more confident in my skin. Um, like, just speaking to people. I still need to work on eye-contact, but I'm a lot more confident. I can walk up to somebody and start a conversation out of the blue. I was just thinking about this a couple days ago. When I first got here I was, like, a little more shy [...] but now I just go up to someone, start a conversation, so I would say I'm a lot more confident, I learned how to communicate efficiently, to get my ideas across and whatnot."* -Emma

### Teamwork

Participant described an increased ability to work effectively with others and/or described a greater understanding of what it means to be a part of a team.

*"I feel like if I never did [science presentations], I would have still, in my head, the thought like, 'It's every man for themselves,' instead of learning that, 'Okay, if I'm gonna build a night light, I gotta have other people help me. I can't just hold the wires and tape it together. I need someone to hold the black wire, while I hold the red wire, and someone else tapes it.'" -Angelica*

A manuscript based on this study is pending publication in a science education research journal and is available upon request.



## Conclusions

- Science presentation experiences facilitated learning-through-teaching experiences for youth, which emerged as an impactful experience related to youths' science learning.
- Youth often indirectly alluded to the role of the longer-term nature of the program as being impactful of their science learning. It is unclear if the same results would emerge from participation in a shorter-term program.

## Strengths & Limitations

- This study contributes to a more nuanced understanding of *how* OST programs contribute to youths' science learning by exploring the role of a particular program feature, learning-through-teaching experiences.
- Youth often referred to the science presentation experiences, but did not always identify the process of LTT specifically.
  - An objective assessment of LTT, such as systematic observations, would strengthen the evidence for the impact of LTT in the science presentation experiences.

## Future Research

- Conduct follow-up interviews with same sample one year post program graduation to explore the longer-term impacts of LTT on youths' science learning and development.
- Explore the role of gender to assess whether LTT is affecting male and female teens' science learning in the same ways.

## Acknowledgment and Contact

- This study was supported by NSF grant #1514593.
- We would like to thank the youth who participated in this study, as well as Ms. Natalie Harris, who contributed to data analysis.
- Dr. Mroczkowski can be reached at: Alison.Mroczkowski@msichicago.org