

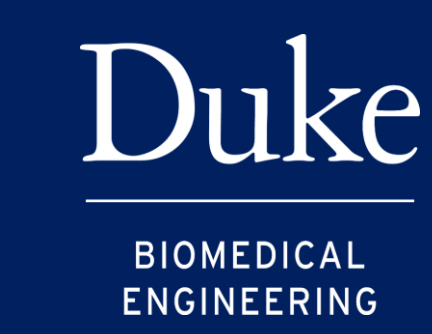


# Impact of Human-Centered Design on STEM- and Community-Identity Formation

Radha Amin<sup>1</sup>, Amaris Huang<sup>1</sup>, Hannah Lee<sup>2</sup>, Marissa Sims<sup>1</sup>, Kerry Eller<sup>1</sup>, Megan Madonna<sup>1</sup>, David Knudsen<sup>3</sup>, Nimmi Ramanujam<sup>1</sup>

1. Department of Biomedical Engineering, Duke University, 2. Department of Computer Science, Duke University

3. The Museum of Life and Science



## Background

### Rationale

- Human-centered design (HCD) and engineering design processes can create innovative solutions to global issues, including the United Nations Sustainable Development Goals.
- Ignite collaborates with The Museum of Life and Science to increase interest in STEM and STEM retention for young students in North Carolina by pairing undergraduates, *Trainers*, and middle school mentees, *Learners*.
- Ignite has a mission of encouraging creative problem-solvers to utilize engineering design while fostering global citizenship, community-involvement, and improving self-perception and attitudes in STEM.

### Objective

- Design and implement a research study that examines how Ignite's 2024 middle school implementation impacts students' attitudes towards community-driven problem solving and their STEM-identity.

## Theoretical Framework

**Research Question:** How does Ignite's community-centered, problem-solving-oriented curriculum impact students' community involvement and engineering identity?

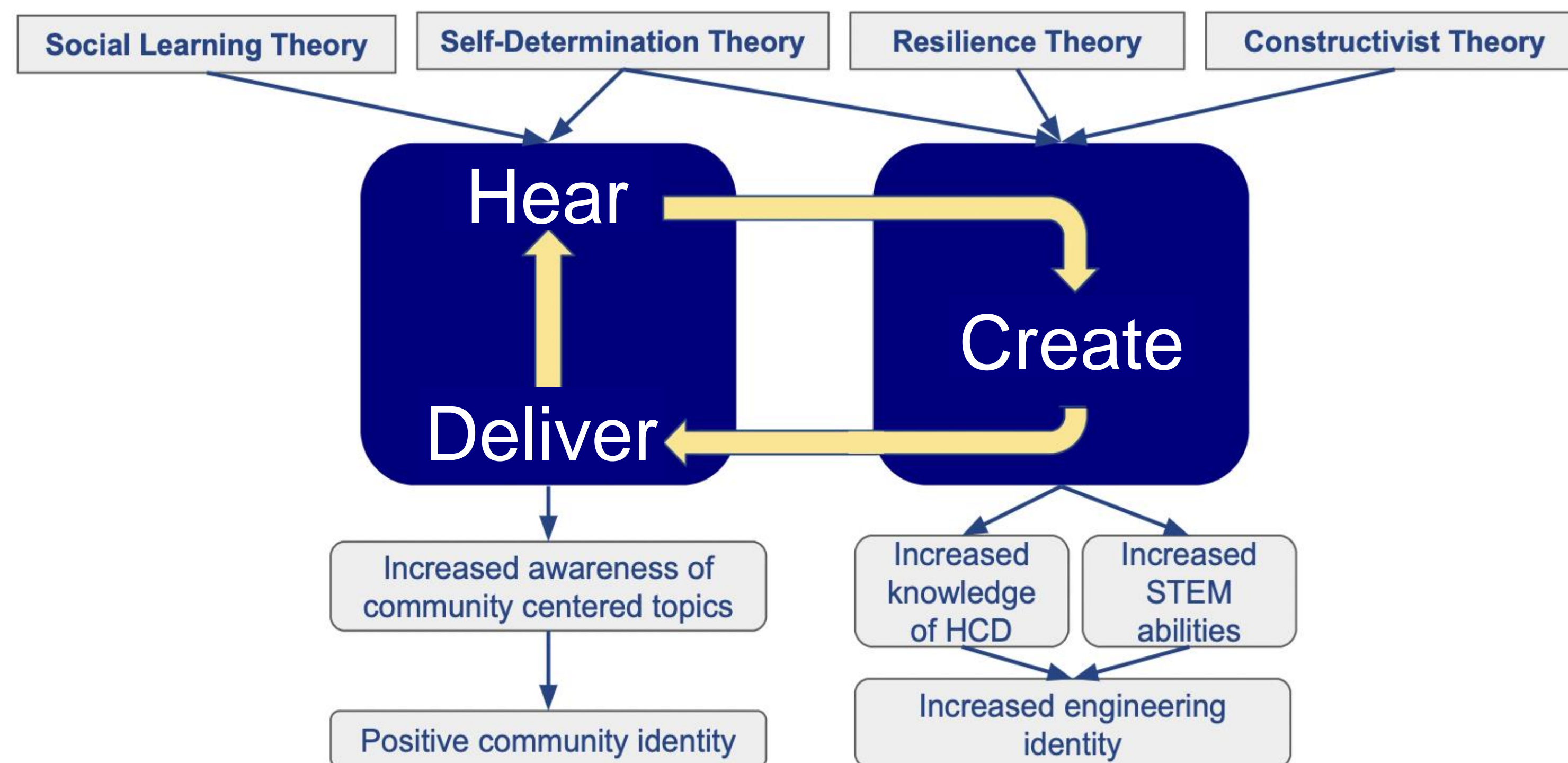


Figure 1. Theoretical framework in relation to Ignite's human-centered design process.

## Methodology

The 8-week middle-school Ignite program took place from January to March 2024; weekly, on-site data collection occurred with each week alternating between in-person and Zoom sessions. The enrollment for the Light, Water and Health programs were N = 20, N = 18, and N = 21 participants, respectively.

For our mixed-methods study, we curated a series of literature-validated metrics to evaluate Ignite's impact, stratified into codes to assess their **community-identity, grit, STEM attitudes, and engineering-identity** scores.

- Metric Identification:** Literature-validated evaluation of community-identity, grit, STEM-attitudes, and engineering-identity
- Metric Data Collection:** 5 point Likert scaled pre- and post-surveys via Qualtrics
- Engagement Data Collection:** Engagement score (+1 for engaged, 0 for neither/absent, -1 for disengaged) at half-way and end-point of each session
- Data Analysis:** All statistical analysis was done through Python3 and Excel



Figure 2. Study implementation and workflow.

## Results

### Demographics

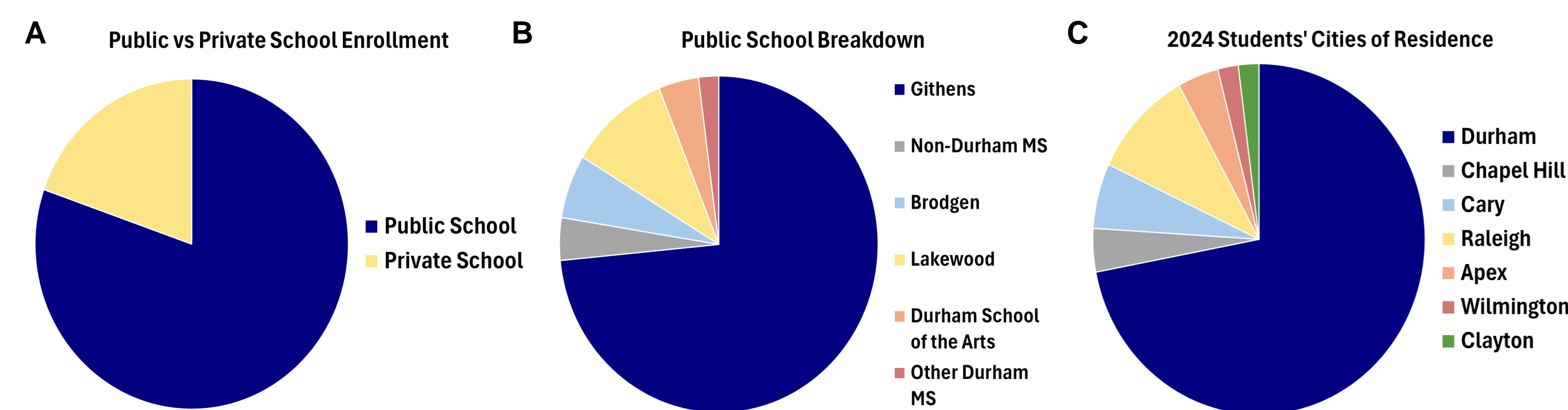


Figure 3. Learner's demographic data. A. Public versus private school enrollment. B. Breakdown of enrolled public schools. C. City of residence.

### Attendance

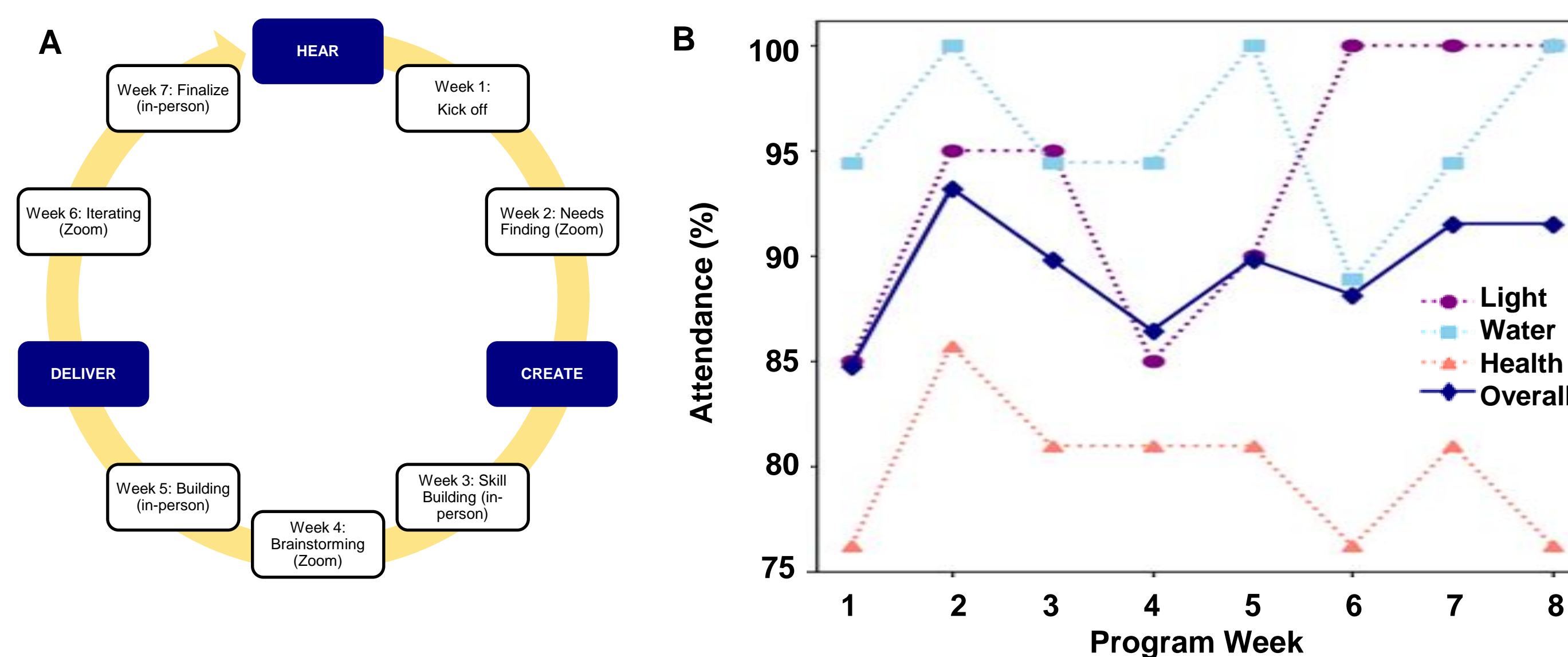


Figure 4. A. Weekly Ignite curriculum. B. Learner's attendance during the 8 week program.

### Engagement

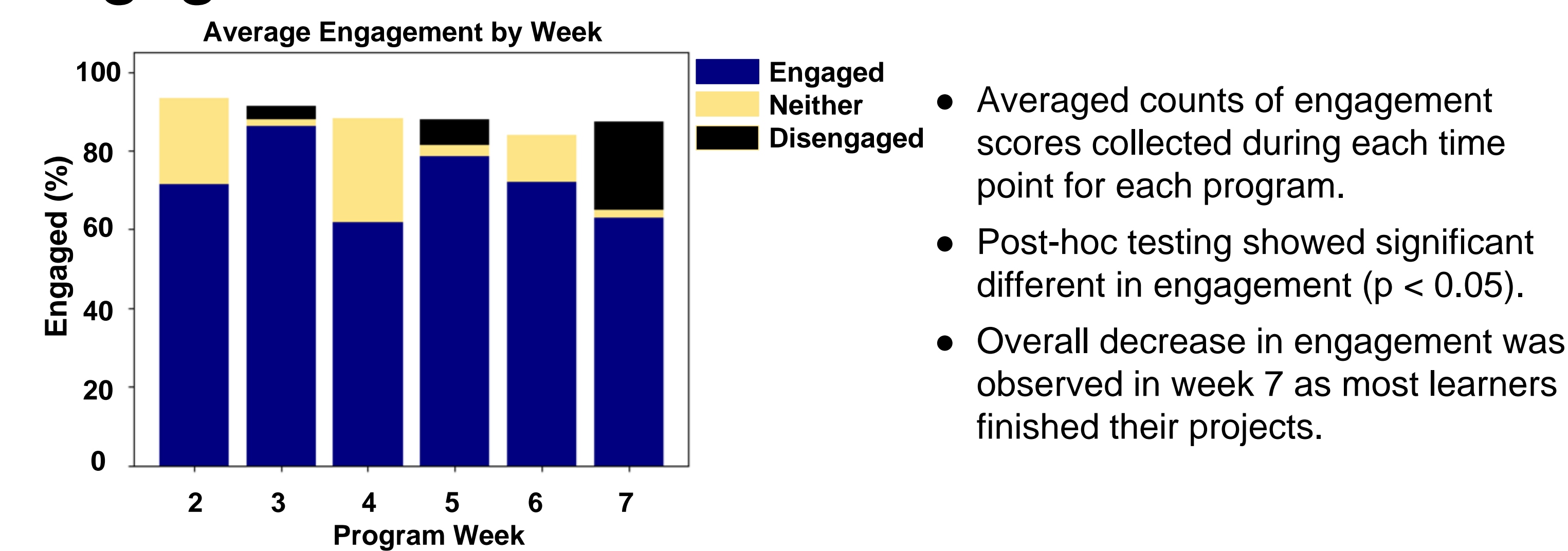


Figure 5. Proportion of engagement scores collected across 8 weeks, encompassing both checkpoints (N=59). Significant difference between week pairs: 2/3, 3/4, 4/5, 4/6, 2/7, 3/7, 5/7, and 6/7 ( $p < 0.05$ ).

### Observational Data

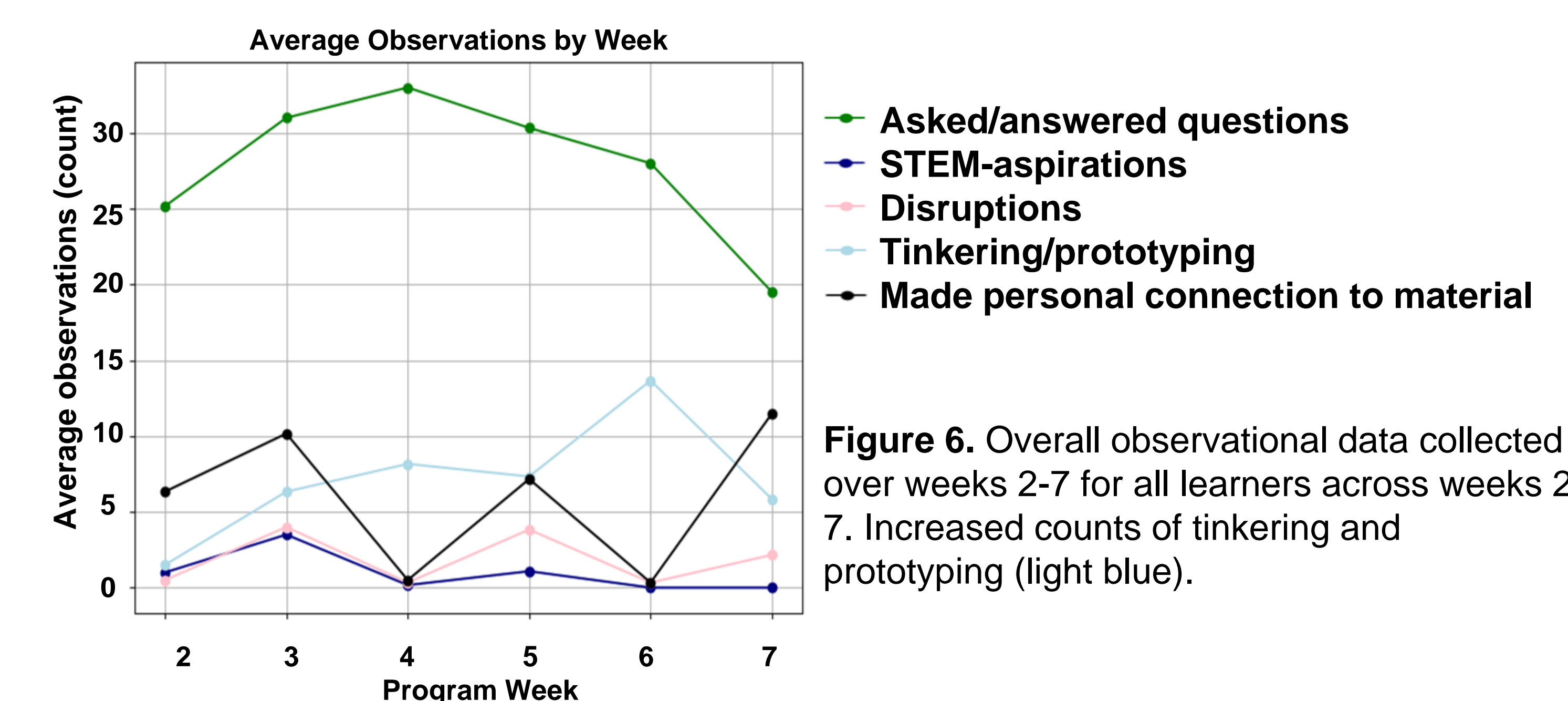


Figure 6. Overall observational data collected over weeks 2-7 for all learners across weeks 2-7. Increased counts of tinkering and prototyping (light blue).

## Results

### Pre-Post Survey Scores

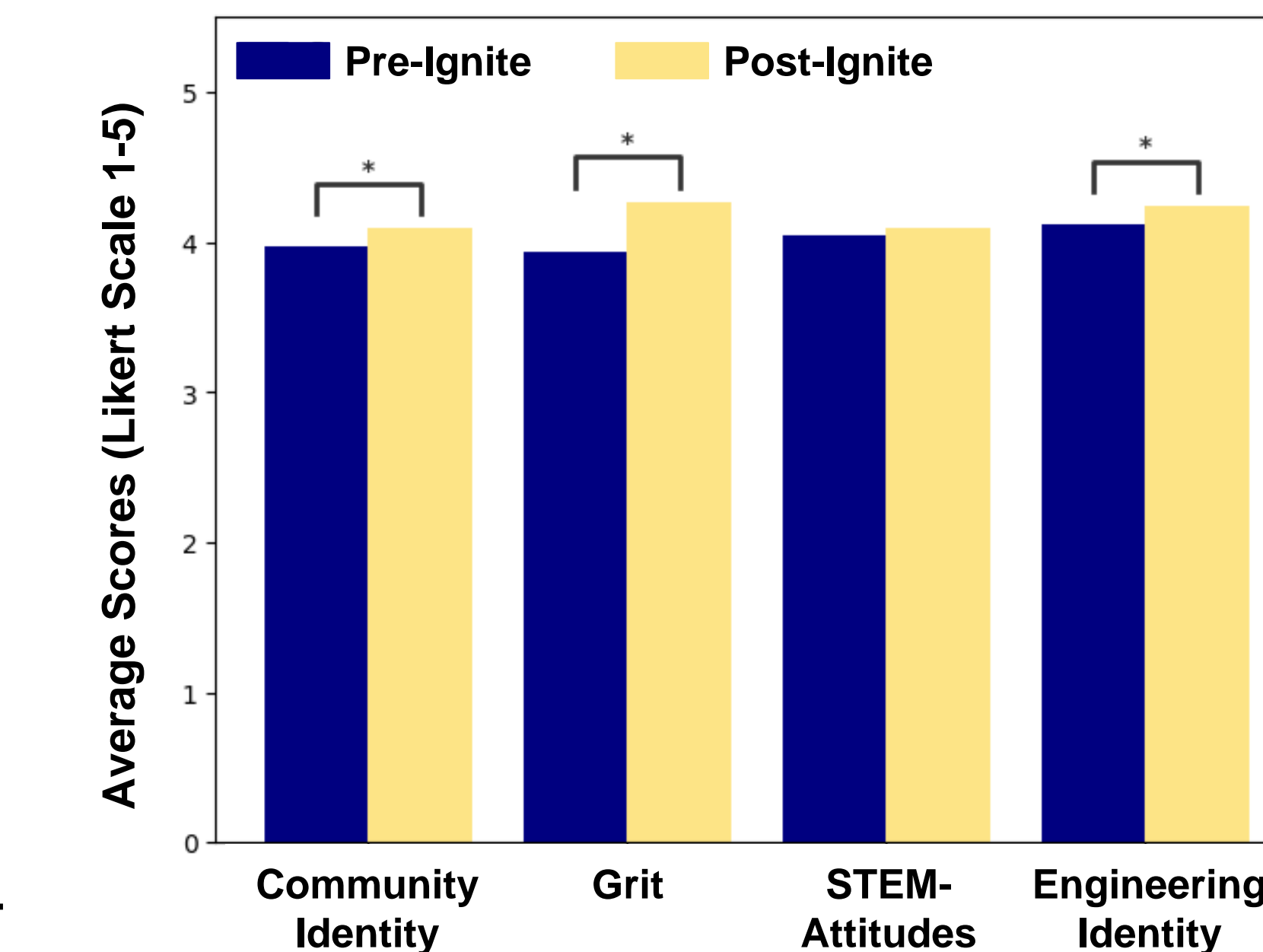


Figure 7. Surveys administered to Learners before and after the Ignite program.

- Averaged the Likert scale questions for the pre- and post-program surveys (N=59), and then performed a paired t-test.
- Community-identity, grit and engineering-identity scores significantly increase over the course of the program ( $p < 0.05$ ).

### Interview Data

Codes	Representative Quotes
Community Identity	"People in my community could have heart diseases or symptoms that could lead to heart diseases so I could use my device to help prevent that." "I like helping my community and building a water filter is definitely something that I can relate to because I've seen a lot of places that don't have clean water."
Grit	"I've learned that like you can't really do everything on the first try and it takes a long time to get something done. I would say don't rush it and if you get a setback you should face it and not get down on it." "I feel good and it should happen and overcoming problems is definitely something you learn and experience."
STEM-Attitudes	"I am in an advanced science class, and I feel really good about it and I'm definitely going to keep taking it throughout high school and stuff. Maybe take a couple of college classes here and there." "I am very confident especially if I decide to go into the field of engineering."
Engineering Identity	"Probably engineer. Yes, I think that Ignite helped me kind of find what I wanted to do in engineering." "I definitely think so. I think I could do a lot of engineering."

## Conclusions

**Ignite significantly increased students' responses for their community identity, grit, and engineering identity scores ( $p < 0.05$ ).**

Ignite works to recruit and empower a diverse population of problem-solvers to create solutions for relevant community issues. The 2024 implementation study focused on Ignite's emphasis on addressing the UN SDGs, showing how Ignite is efficacious in improving students' grit, community-identity and engineering-identity scores. In the future, our program can now be adapted to further improve the HCD curriculum's impact in fostering global citizenship and community-oriented problem-solving.

## Future Work

- Summer 2024 Data+ Team**
  - Analyze common themes across interview, survey, and observational data
- 2024-2025 Bass Connections Team: Improving Students' STEM Identity Through Design and Tinkering**
  - Implement improvements and collect more data for analysis
  - Compare to the 2024 data baseline

For more information:  
Contact Megan Madonna at [mcm84@duke.edu](mailto:mcm84@duke.edu)  
or <https://www.gwht-ignite-learning.com/>.

References:

