Spatial Reasoning and Problem-based Learning to Improve Girls' Math Identity

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Background

- While the number of girls and women pursuing STEM careers has increased over the years, women are still under-represented at the upper levels of educational and professional attainment.
- In primary and secondary education:

Girls and boys score equally on standardized math tests in 4th grade. → Girls take fewer AP exams in STEM subjects than boys in high school.
such as calculus, physics, computer science, and chemistry.

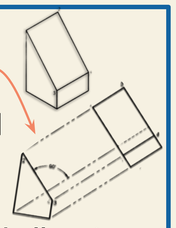
- Continuing into tertiary education and the workfield, only **24% of people in STEM careers are women**.
- In the absence of any meaningful biological or innate gender difference, **cultural factors** account for the difference in representation.

Methods

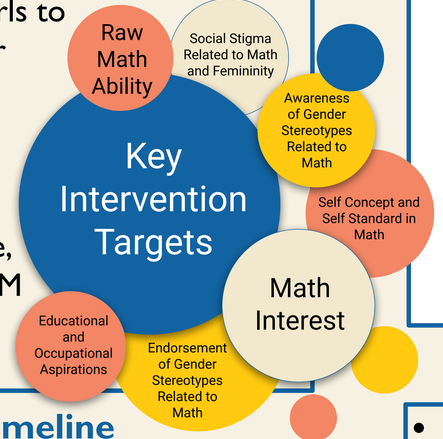
- GEM encourages young women to explore math during two-hour workshops from Jan-Apr, along with a summer component, Pen & Puzzle Pals.
- Girls participate in problem-based math activities guided by 2 mentors.
- Mentors discuss cultural factors known to influence students' identities including stereotype threat, gender norms, and beliefs about intelligence (fixed vs. growth mindset).
- Changes in math ability and mindset following the workshops are assessed through pre- and post-tests.
- Pen & Puzzle Pals: Girls will pair up with an undergraduate/graduate mentor to correspond over email about interests and puzzles.

What Makes GEM Different?

- **Spatial reasoning components:** Using isometric perspective and visualization exercises, workshops aim to improve spatial reasoning skills as it is the only measurable gender disparity.



- **Problem-based learning**: Girls work on challenging puzzles in groups to develop problem-solving skills and explore math outside of standard school curriculum
- **Awareness of gender issues related to STEM:** Direct discussion of gender, identity, and reasons for the gender gap in STEM through gender-themed talks.
- **Female mentors**: Research has shown that having female mentors is essential for girls to continue on a STEM education or career path.
- **Covers STEM leak points in middle school and college**: In middle school, girls often start losing interest in STEM. In college, women often don't pursue a STEM degree, and those that do often don't pursue a STEM career.



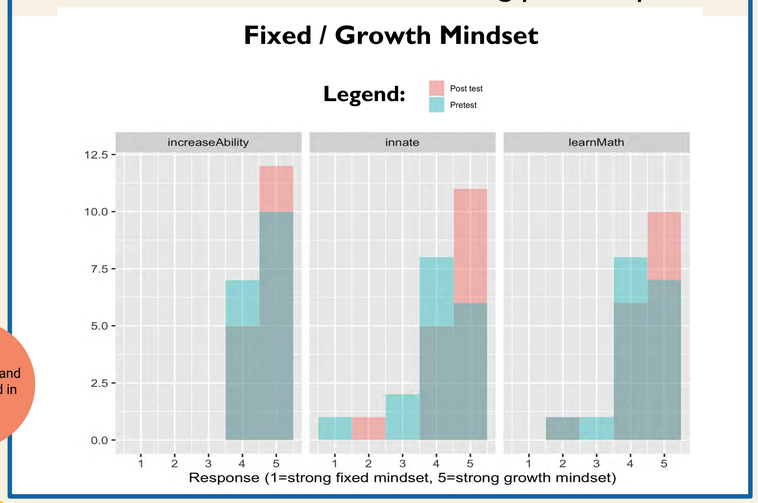
Current Research Timeline

Participants and Assessment (2019)

57 Initial Enrollees:
25% 8th Grade, 39% 7th Grade, 36% 6th Grade

Results (2019 Data)

1. **Growth mindset** became stronger.
2. **Confidence in specific math problem solutions improved**, but overall confidence in math did not change.
3. **Math test scores** were higher.
4. Girls attributed the STEM gender gap more to the **lack of confidence** and **discrimination.**
5. **Perceived rank in math** among peers improved.



Future Directions

- Develop a **scalable workshop model** to implement program in other universities, particularly in rural areas.
- Assess **the effectiveness of remote and online learning** programs.

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