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

Dr. Sophia Santillan¹, Dr. Tori Akin², Dr. Lauren Valentino³
Graduate Student: Aidan Combs
Undergraduate Students: Becca Erenbaum, Pingyi Zhu, Preethi Kannan, Selena Qian, Michelle Yin, Vivian Chen, Ashley Rosen

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:
  - 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.

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.

Participants and Assessment (2019)

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