Relations Among Sense of Belonging to Math, Math Identity, and Math Achievement in the Late Elementary Grades

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Background

- Students' sense of belonging to math is an important predictor of middle school students' algebra learning (Barbieri & Miller-Cotto, 2021).
- Middle school students' math belonging partially explains the relation between under-represented minority (URM; i.e., non-Asian ethnic and racial minority) status and lower algebra scores (Barbieri & Miller-Cotto, 2021).
- Prior measures of students' sense of belonging to math (Barbieri & Miller-Cotto, 2021; Good et al., 2012) and math identity (Cribbs et al., 2015) have been used with middle school and undergraduate populations; however, no prior research has examined these constructs with younger students.

Research Questions

In the current study, we aimed to:

- 1) Modify existing measures of sense of belonging to math and math identity to be used with upper elementary grades and examine the reliability of the measures
- 2) Examine relations between these modified survey measures and students' math achievement

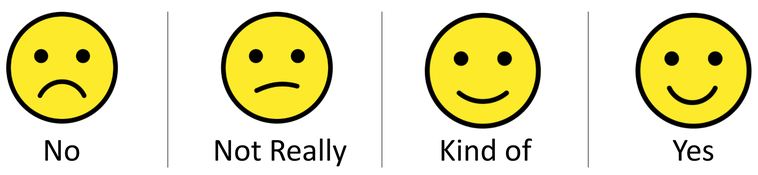
Method

Participants: 89 students (22 3rd graders, 55 4th graders, 12 5th graders; 50 girls, 37 boys, 2 not reported; 53% White, 16% Black or African American, 13% Hispanic or Latino/e, 15% Multiracial, 3% not reported; 20% of students with at least one parent with an Associate's degree, 3% with a Bachelor's degree or higher, 8% not reported) from a school district in the Midwestern U.S.

Procedure: Research assistants administered the measures below in person in November 2021, in the classroom setting, as part of a larger pilot study. Measures were adapted in co-design sessions with the research team and district partners to ensure the work was intentionally grounded in equity.

Measures:

- **Sense of Belonging to Math**
  - Adapted from Barbieri and Miller-Cotto's (2021) measure
  - When we are doing math,
    - …I feel like I am part of the math community
    - …I feel accepted
    - …I feel comfortable
    - …I trust my teachers to help me learn
    - …I enjoy participating
  - Each item had the four response options below:



- **Math Identity**
  - Adapted from Cribbs et al.'s (2015) measure
  - Items from factors of *recognition* (6 items; e.g., "I see myself as a math person," "My math teacher sees me as a math person") and *competence* (6 items; e.g., "I am confident that I can understand math when I can't ask the teacher for help," "I can overcome challenges in math")
  - Likert scale with 4 response options (same scale as above, coded 0-3)
- **Standardized Math Test Scores** (obtained from schools)
  - Measures of Academic Progress, assessed in December 2021
- **Demographic Survey** (completed by parents)
  - Education for both primary and secondary caregivers (highest used as a proxy for socio-economic status), child racial identity, child gender

Results

- Internal consistency for the math belonging measure was acceptable (α = .79).
- The math identity measure subscales exhibited good internal consistency, including factors of recognition (i.e., identification as a "math person", α = .86) and competence (α = .84).
- Math belonging was highly correlated with recognition (*r* = .71) and competence (*r* = .66), but of the three scales only competence was significantly correlated with math achievement (*r* = .35, *p* = .002).
- Exploratory analyses revealed that the correlation between competence and achievement was significant in 4th and 5th grades but not in 3rd grade. It was also significant for non-URM students (*n* = 44) only, even when controlling for socioeconomic status.

Zero-Order Correlations Among Study Variables

Variable	1	2	3	4	5	6
1. Student Grade Level	-					
2. Parent Education[a]	-.12	-				
3. Math Belonging	-.03	-.11	-			
4. Math Identity: Recognition	-.15	-.15	.71***	-		
5. Math Identity: Competence	-.06	.08	.66***	.67***	-	
6. Math Achievement	.44***	.10	.13	.05	.35**	-

Note. *$p < .05$, **$p < .01$, ***$p < .001$

[a] : 0 = 8th grade or less, 1 = Some high school, 2 = GED, 3 = HS diploma, 4 = Some college, 5 = Associate's degree, 6 = Bachelor's degree, 7 = Master's degree, 8 = Doctoral or professional degree. Correlations between parent education and each other variable are nonparametric (Spearman's rho).

Discussion

- Overall, although each measure had decent reliability, only competence was related to math achievement in the current sample.
- Future research is needed with larger and more diverse samples to examine the directionality of these relations, as well as how students' sense of belonging to math and math identity may relate to their progression to more advanced mathematics in middle school and beyond.
- Future work should also examine the malleability of these attitudes in response to specific activities designed to promote positive math identity and math belonging, particularly for URM students, and whether improvements in math identity and belonging may transfer to math learning.

References

- Barbieri, C. A., & Miller-Cotto, D. (2021). The importance of adolescents' sense of belonging to mathematics for algebra learning. *Learning and Individual Differences*, *87*, 101993.
- Cribbs, J. D, Hazari, Z., Sonnert, G., & Sadler, P. M. (2015). Establishing an explanatory model for mathematics identity. *Child Development*, *86*(4), 1048-1062.
- Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology*, *102*(4), 700-717.

Acknowledgments

Special thanks to the administrators, teachers, and students from the participating schools. The research reported here was supported by the EF+Math Program of the Advanced Education Research and Development Program (AERDF) through funds provided to Purdue University. The opinions expressed are those of the authors and do not represent views of the EF+Math Program or AERDF.