Person-Oriented Approach to Math Anxiety, Math Performance and Math Self-Efficacy Associations

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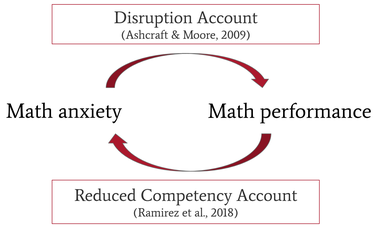
Background & Research Questions

- Research shows that anxiety in mathematics negatively correlates with mathematics performance:



- Some studies examined potential moderators in these relationships, showing that some highly math anxious students still perform well in mathematics (Ramirez et al., 2018).
- However, few studies examine how often students diverge from this linear relationships and which other variables can explain potential deviation from reduced competency account theory.

RQ1 How many groups will emerge if we cluster students based on their math anxiety and performance?
RQ2 How students from those clusters differ in math anxiety, performance, and self-efficacy?

Study 1

Participants. 1,029 students in 7th grade (typically 13-14-year-olds) from 11 US schools. 47% girls, 50% White, 27% Asian, 16% Hispanic/Latino, 7% Other.

Methodology. Online survey administered by teachers during math class across 2020-21 school year. A total of 76% of students attended class in person, others – remotely.

Math performance. Items adapted from Star et al. (2015): 4 – conceptual understanding in algebra, 3 – procedural knowledge, and 3 – math flexibility (see osf.io/bafdr). No feedback was given.

Math anxiety. Math Anxiety Scale for Young Children-R (Ganley & McGraw, 2016).

Math self-efficacy. Academic Efficacy subscale of the Patterns of Adaptive Learning Scales (Midgley et al., 2000) adapted for math.

Study 2

Participants. 473 6th grade students from 14 US schools. 49% girls, 85% White, 5% Multi-racial, 3% Black, 3% Hispanic/Latino.

Methodology. Online survey administered during the math class time across 2023-24 school year. All students were in person.

Math performance. 12 order-of-operations problems (Joseph, 2014). No feedback was given.

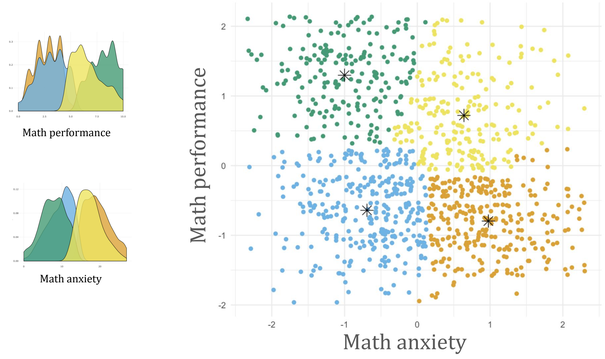
Math anxiety measure. The same as in study 1.

Data Analysis Methods

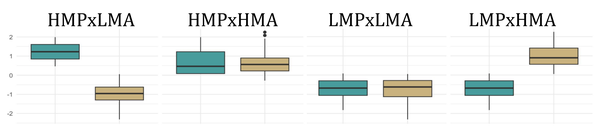
- K-means clustering (with elbow method and silhouette scores)
- Kruskal Wallis H-test, Dunn tests with Bonferroni correction
- Regression analysis with a moderator

Results: RQ1

Study 1



All clusters differed significantly from each other in performance, except for the low-performing clusters. Only the low-anxious clusters did not differ significantly in anxiety.

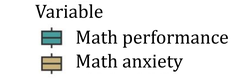


Difference in math performance / math anxiety:

	HMPxHMA	HMPxLMA	LMPxHMA
HMPxLMA	– 4.5*** / 17.7***		
LMPxHMA	18.1 *** / – 3.5*	22.3*** / – 22.1***	–
LMPxLMA	16.3 *** / 16.2***	20.6*** / – 3.2 (p = .2)	– 2.4 (p = .05) / 21.2***

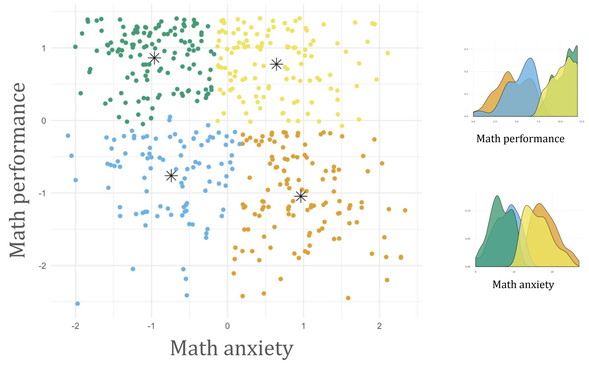
Both studies showed 4 distinct clusters:

- High Math Performance, How Math Anxiety (HMPxLMA): study 1 n=205, study 2 n=130
- High Math Performance, High Math Anxiety (HMPxHMA): study 1 n=225, study 2 n=120
- Low Math Performance, LowMath Anxiety (LMPxLMA): study 1 n=314, study 2 n=98
- Low Math Performance, High Math Anxiety (LMPxHMA): study 1 n=285, study 2 n=125

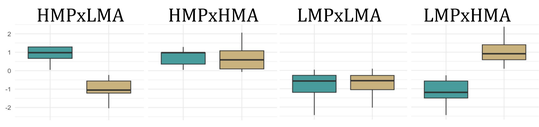


Note. All math performance, anxiety and self-efficacy tables show pairwise Dunn test comparisons with Bonferroni correction. Statistics show absolute difference, df = 3.
*** p < .001. * p < .05
Pearson's correlations (p < .01 for all):
Study 1: MA and MP: r = -.23 [-.29, -.17], MA and MSE: r = -.56 [-.60, -.52], MP and MSE: r = .35 [.30, .41].
Study 2: MA and MP: r = -.27 [-.35, -.18]

Study 2



Differences in performance were similar to Study 1, except that high-performing clusters did not differ in performance. Differences in anxiety were similar to Study 1.



Difference in math performance / math anxiety:

	HMPxHMA	HMPxLMA	LMPxHMA
HMPxLMA	– 0.9 (p = 1)/ 13.1***		
LMPxHMA	14.0***/–2.4 (p=.05)	15.1*** / – 15.7***	–
LMPxLMA	11.4*** / 10.5***	12.4***/ – 1.7 (p=.3)	– 1.8 (p=.2) / 13.0***

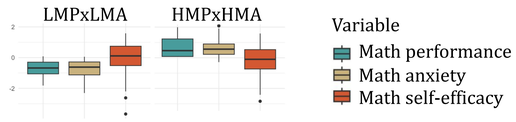
Results: RQ2

All clusters significantly differed in their self-efficacy.

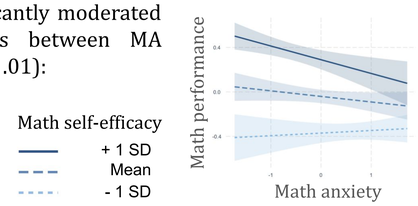
Difference in math self-efficacy (MSE):

	HMPxHMA	HMPxLMA	LMPxHMA
HMPxLMA	–10.2***		
LMPxHMA	6.9***	17.5***	–
LMPxLMA	–2.8 (p=.02)	8.4***	–10.6 (p = .003)

Cluster with low performance and low anxiety showed slightly but significantly higher level of math self-efficacy than cluster with high performance and high anxiety:



MSE significantly moderated relationships between MA and MP (p < .01):



Conclusions

- Clustering showed the extent to which students tend to deviate from the traditional linear perspective on association between math performance (MP) and math anxiety (MA) and two directions of this deviation.
- In about one-fourth of students, high MA did not prevent them from showing high levels of MP. However, in the Study 1, those students demonstrated significantly lower performance compared to high-performing low-anxious students – supporting the idea that high anxiety can prevent students from performing at the highest level.
- Deviation from the reduced competency account theory in another quarter of participants can be associated with their differences in self-efficacy, signaling that students from this cluster could overestimate their math abilities and, thus, not experience increased negative feelings around math.
- These findings highlight the importance of searching and always accounting for moderation variables when aiming to predict performance from anxiety and vice versa.

Funding

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305A180401 (Study 1) and the National Science Foundation, through an ECR Core grant (2300764) to WPI (Study 2).

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