



Longitudinal Relationships Between Mathematical Achievement, Anxiety, and Attitudes in Middle School Students

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Introduction

Abstract

- ❖ Sex differences in mathematics are generally small (Hyde, Fennema, & Lamon, 1990), but there tends to be more males at the higher end of performance (Wai, Hodges, & Makel, 2018).
- ❖ From 6th to 7th grade earlier math achievement predicted later anxiety and attitude, but earlier anxiety and attitudes did not predict later achievement (Geary et al. 2019).
- ❖ In this follow-up study, 7th grade math achievement predicted 8th grade attitudes and 7th grade attitudes predicted 8th grade achievement, but only for girls.

Sex Differences in Mathematics Anxiety

- ❖ Defined as an apprehension or fear which is associated with thoughts or engagement with mathematical activities (Ashcraft, 2002; Dowker, Sarkar, & Looi, 2016).
- ❖ Higher mathematics anxiety is associated with lower math performance (Ma, 1999), and females tend to experience greater levels of anxiety and potentially larger consequences than males (Hyde, Fennema, Ryan, Frost & Hopp, 1990; Stoet, Bailey, Moore, & Geary, 2016).
- ❖ There are strong relationships between math achievement and anxiety in girls than boys, indicating that it may be an underlying factor in achievement gaps. However, most of the research is correlational and the direction of the relationships is undetermined (Dowker et al, 2016).

Sex Differences in Mathematics Attitudes

- ❖ Students' valuation of mathematics depends on perceived usefulness for future job or importance in school achievement (Gaspard et al, 2015).
- ❖ Sex differences in overall academic self-efficacy are very small (Hedge's $g = .08$), but overall boys and men have higher math efficacy (Hege's $g = .18$) and girls and women have higher efficacy in language arts (Hedge's $g = .16$; Huang 2013).
- ❖ For children and adolescents combined, it was found that earlier levels of academic achievement were related to later levels of efficacy, but early levels of efficacy were not related to later achievement; these studies, however, did not assess sex differences (Talsma, Schutz, Schwarzer, & Norris, 2018)

Hypothesis

- ❖ Hypothesis 1: Achievement in mathematics in 7th grade will influence anxiety and attitudes for girls in 8th grade
- ❖ Hypothesis 2: Achievement in 7th grade mathematics will not influence anxiety and attitudes in math for boys in 8th grade
- ❖ Hypothesis 3: Anxiety and attitudes in 7th grade math will not predict math achievement in 8th grade for girls
- ❖ Hypothesis 4: Anxiety and attitudes in 7th grade will not predict math achievement in 8th grade for boys

Methods

Participants

Number	190 (7 th); 184 (8 th)
Age	12 years 3 months (6 th) 14 years 0 months (8 th)
Gender	97 boys, 93 girls (7 th) 94 boys, 90 girls (8 th)
Ethnicity	White (59%) Black (12%) Asian (4%) Hispanic (4%) Multiracial (8%) Non-reporting (16%)

Procedure

For both 7th and 8th grade, achievement, attitudes, and anxiety assessments were conducted one-on-one in a quiet location in their school. The assessments were part of a larger assessment which took about 45 minutes to complete. The Numerical Operations test was used to assess math achievement (Wechsler, 2003). The anxiety and attitudes survey were assessed using an iPad and were standard measures of these constructs.

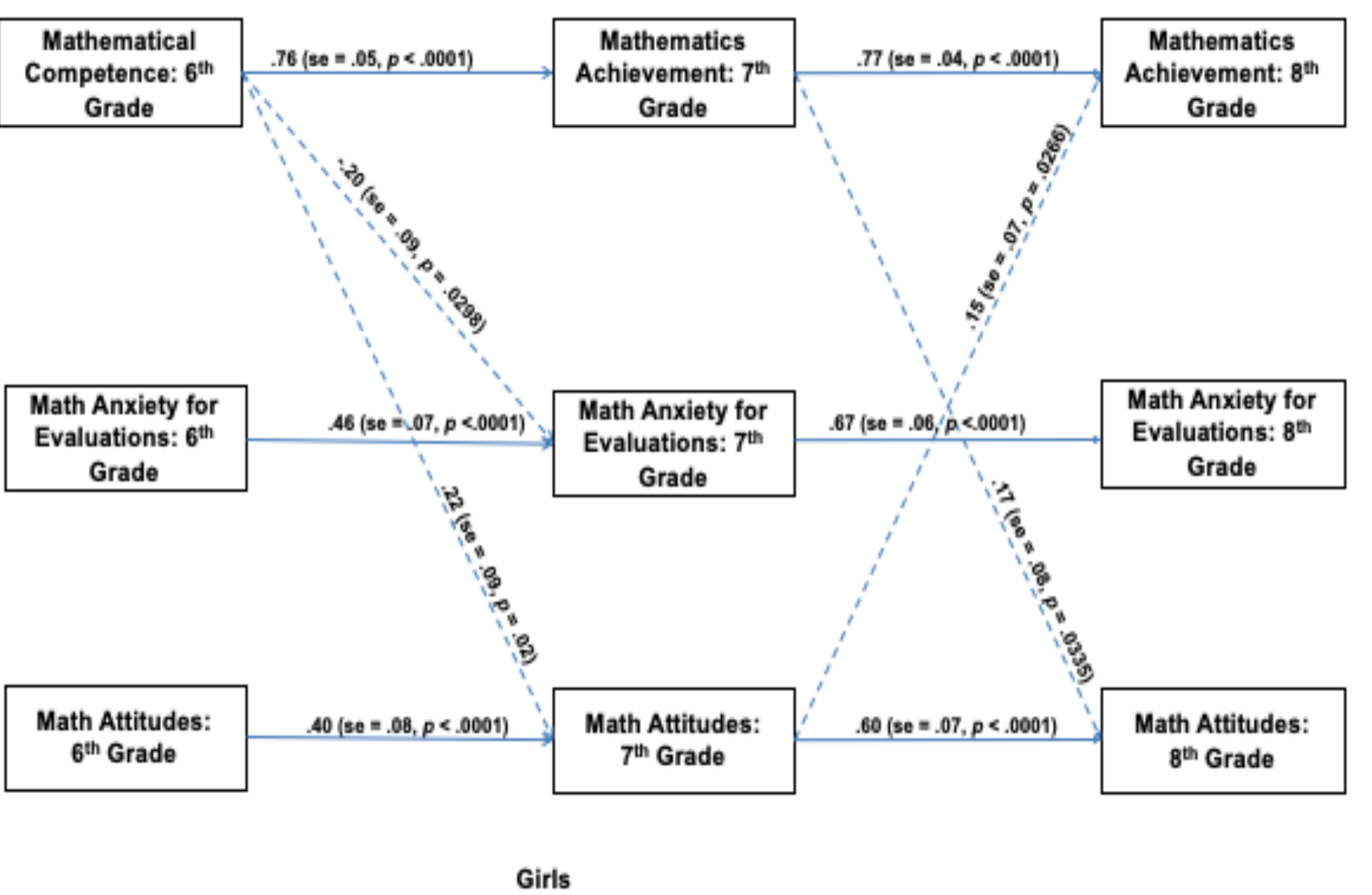
Measures

Achievement Tests: The Numerical Operations test is a subtest for the Wechsler Individual Achievement Test, 3rd Edition (Weschler, 2009) and begins with basic arithmetic and gradually progressed in difficulty to algebra, geometry, and calculus.

Academic Attitudes: Mathematics and English attitudes were adapted from the Michigan Study of Adolescent and Adult Transitions (<https://garp.education.uci.edu/msalt.html>) and math attitudes were measured on a 1-to-7 Likert scale; the attitude score was a mean of the 7 items ($\alpha=.84$)

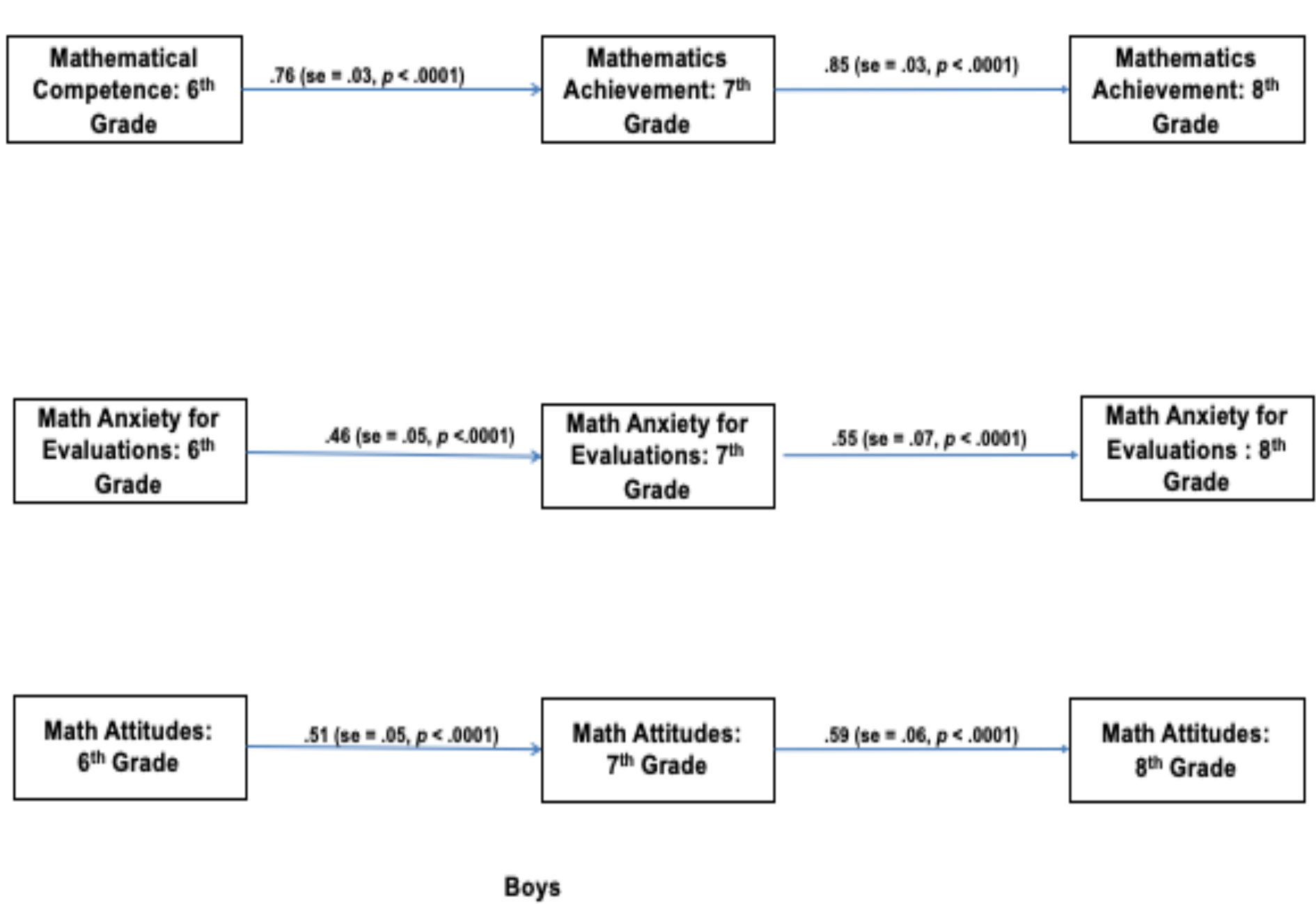
Academic Anxiety: Math anxiety was a 10-item test adapted from Hopko, Mahadevan, Bare, & Hunt (2003); each item was rated on a 1 (low anxiety) to 5 (high anxiety) scale and composite scores were based on factor analyses by Geary et al. (2019). Five items were associated with learning about math (e.g. reading a math book, $\alpha=.76$) and five items associated with being evaluated in math (e.g. taking a test, $\alpha=.81$). The factors were moderately correlated ($r = .47$).

Results



Girls

Path analyses revealed that all of the year-to-year paths were significant for the same measures ($ps < .001$). Math achievement in 7th grade was not related to math anxiety in 8th grade ($\beta = -0.03$, $p = .605$), but reciprocal relations between achievement and attitudes emerged; 7th grade achievement to 8th grade attitudes ($\beta = 0.17$, $p = .0335$) and 7th grade attitudes to 8th grade achievement ($\beta = 0.15$, $p = .0266$).



Boys

Path analyses revealed that all of the year-to-year paths were significant ($ps < .001$). None of the paths between math achievement and math attitudes and anxiety were significant for boys ($ps > .10$)

Discussion

❖ **Hypothesis 1: Partially Supported** – For girls, achievement in mathematics in 7th grade did influence 8th grade attitudes in math but did not influence 8th grade anxiety in math (not shown in Figure).

❖ **Hypothesis 2: Fully Supported** – For boys, achievement in mathematics in 7th grade did not influence 8th grade math attitudes or 8th grade math anxiety.

❖ **Hypothesis 3: Partially Supported** – For girls, math anxiety in 7th grade did not predict math achievement in 8th grade, but math attitudes in 7th grade predicted math achievement in 8th grade.

❖ **Hypothesis 4: Fully Supported** – For boys, neither math anxiety nor math attitudes in 7th grade predicted math achievement in 8th grade.

Conclusion: While year-to-year predictions for achievement, attitudes, and anxiety in math correlate from 6th to 8th grade, the influence of math anxiety and math attitudes on achievement and vice versa seem to be a mediating factor for girls, but not for boys. These sex differences might contribute to sex differences in mathematics achievement.

Future Directions: Future studies should examine the impact of other factors on these reciprocal relations in math achievement, anxiety, and attitudes as it relates to things such as socioeconomic status, race, and geographic location.

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