Prior achievement and subject-specific anxiety as key predictors of grade 5 mathematics achievement

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Summary

Students' mathematics achievement is often associated with both general and subject-specific attitudes; however, it remains unclear whether mathematics performance is better explained by general academic anxiety and learning-related interest or by mathematics-specific anxiety and interest. This study investigates whether general or mathematics-specific factors more strongly predict Grade 5 mathematics achievement, while accounting for gender and prior mathematics performance in Grade 3.

The results show that Grade 5 mathematics achievement is predicted by mathematics-specific anxiety and prior performance. In contrast, general academic anxiety and interest do not add explanatory value beyond subject-specific variables. Girls reported higher levels of anxiety in both mathematics and general academic areas, and lower mathematics interest than boys, despite comparable mathematics achievement. No gender differences were observed in general learning interest or mathematics performance.

These findings highlight the importance of distinguishing between general and subject-specific emotional factors as subject-specific experiences appear to play a more prominent role in mathematics achievement.

Methology

The study was based on two data collections conducted in 2019 and 2021. The first focused on a Grade 3 mathematics competence test administered in Estonian schools through the national examination system. Schools were contacted via the Education and Youth Board (formerly SA Innove), which was responsible for coordinating educational development and supporting schools.

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In the follow-up study, the same schools were contacted. In both data collections, students completed an online self-report questionnaire and then took a mathematics test. The study was conducted in Estonian, and participants were required to have proficiency in Estonian. All research procedures were approved by an ethics committee, and informed consent was obtained from both students and their parents.

In Grade 3, 846 students participated (55.3% girls), and in Grade 5, 317 students completed all measures (50.5% girls). A total of 126 students participated altogether; the reduced longitudinal sample was primarily due to external factors such as illness and periods of distance learning.

Measures

Students completed an 18-item self-report questionnaire assessing anxiety and interest. General academic anxiety and mathematics anxiety were each measured with 5 items, while general learning interest and mathematics interest were assessed with 4 items each. Responses were recorded on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

After completing the questionnaire, students took a mathematics competence test aligned with the Estonian national curriculum. The tests assessed conceptual and procedural mathematics skills, producing a total mathematics achievement score in both Grade 3 and Grade 5.

General academic anxiety

Students' general academic anxiety was assessed using five modified items from the Abbreviated Math Anxiety Scale (mAMAS; Carey, Hill, et al., 2017). These items were adapted to assess general academic anxiety, rather than specific anxiety related to any particular subject. Three items measured general learning anxiety (e.g., "I feel anxious if I need to learn by myself."), while two assessed test anxiety (e.g., "I feel anxious while taking a test."). The scale demonstrated good internal consistency, with a Cronbach's $\alpha = .81$ and McDonald's $\omega total = .86$. A confirmatory factor analysis (CFA) further supported a one-factor model, showing an adequate fit: $\chi 2$ (5, N = 335) = 25.606, CFI = 0.981, TLI = 0.962, RMSEA = 0.111 [90% CI: 0.071 to 0.155]. Factor loadings ranged from .56 to .74. A factor score derived from this model was used in subsequent analyses.

Mathematics Anxiety

Mathematics anxiety was also measured using five modified items from the mAMAS (mAMAS; Carey, Hill, et al., 2017), tailored to capture subject-specific anxiety. Three items addressed mathematics learning anxiety (e.g., "I feel anxious when we start with a new topic in mathematics class."), and two focused

on mathematics test anxiety (e.g., "I feel anxious while taking a mathematics test."). The scale exhibited strong internal reliability, with a Cronbach's α = .89, McDonald's ω_{total} = .92. A confirmatory factor analysis (CFA) confirmed a satisfactory one-factor model fit $\chi 2$ (10, N = 335) = 15.911, CFI = 0.996, TLI = 0.991, RMSEA = 0.081 [90% CI: 0.038 to 0.127]. Factor loadings ranged from .73 to .85. As with general academic anxiety, a factor score was computed from this model for subsequent analyses.

Learning Interest

General learning interest was assessed with four items adapted from the Motivated Strategies for Learning Questionnaire (Pintrich et al., 1993), a scale previously used in Estonia (e.g., Authors). An example item is: "Learning is interesting for me." This scale demonstrated good internal consistency, with a Cronbach's α = .89 and McDonald's ω = .91.

Mathematics Learning Interest

Mathematics learning interest was also measured using four items adapted from the Motivated Strategies for Learning Questionnaire (Pintrich et al., 1993). An example item includes: "Solving mathematics problems is interesting for me." This scale showed good internal consistency, with a Cronbach's α = .94 and McDonald's ω = .95.

Mathematics Achievement Tests for Grade 3 and Grade 5

Mathematics achievement in both grades was evaluated using a test specifically designed based on the Estonian national curriculum. The test consisted of multiple tasks assessing both conceptual and procedural mathematics skills. Conceptual skills were measured through three multi-step tasks that allowed students to solve problems without necessarily creating their own strategies. Procedural skills were assessed through ten tasks involving addition, subtraction, multiplication, and division, often linked to calculations required for conceptual tasks. Each correct answer earned one point, and these points were summed to generate a total mathematics test score. The Grade 5 test shared the same structure as the Grade 3 test, but the difficulty level of problems was adjusted to align with the curriculum expectations for the respective grade.

Results

Correlation analyses indicated that mathematics-specific constructs were more strongly associated with mathematics achievement than general academic constructs. Mathematics anxiety showed moderate negative correlations with both

the Grade 3 and Grade 5 mathematics test scores, whereas academic anxiety was even more weakly related to performance. Similarly, mathematics interest was more strongly associated with mathematics test outcomes than general academic interest, which showed no statistically significant association with Grade 3 performance. As expected, Grade 3 and Grade 5 mathematics test scores were strongly positively correlated, indicating substantial stability in mathematics performance over time.

Significant gender differences were found in mathematics-related emotions: girls reported higher academic and mathematics anxiety and lower interest in mathematics than boys. However, no gender differences were found in general academic interest or in mathematics test scores.

A stepwise multiple regression analysis was conducted to predict Grade 5 mathematics achievement. The final model included Grade 3 mathematics performance, mathematics anxiety, and mathematics interest, while gender and general academic anxiety and interest were excluded. The model explained 51% of the variance in Grade 5 mathematics achievement ($R^2 = 0.51$). Prior mathematics performance was the strongest positive predictor, while mathematics anxiety was a significant negative predictor; however, mathematics interest was not a statistically significant predictor.

Conclusion

This study demonstrates that mathematics-specific anxiety is a distinct and meaningful predictor of mathematics achievement in elementary school, even after controlling for prior performance. Although general academic and mathematics anxiety are strongly related, only mathematics-specific anxiety is associated with mathematics outcomes.

Girls reported higher anxiety and lower mathematics interest despite achieving at a similar level to boys, highlighting the relevance of emotional factors in mathematics learning. Together, these findings underscore the importance of focusing on subject-specific emotional experiences and early achievement trajectories when examining mathematics performance.

Ultimately, by understanding the distinct roles of different anxieties and recognising early academic trajectories, we can better support students' emotional well-being and cultivate a generation more confident and proficient in mathematics.

Keywords: academic anxiety, mathematics anxiety, interest, achievement, mathematics