

Reciprocal Relationship Between Math Self-Concept and Math Achievement Over Time

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Introduction

Did you know that how students perceive themselves as learners can have a profound impact on their academic journey? *Academic self-concept* refers to students' subjective evaluation of their abilities in comparison to those of their peers and of their competence in various subjects. Research has consistently shown a strong connection between students' academic self-concept and their academic achievement.

In this research brief, we delve into the intriguing relationship between math self-concept and math achievement among students in Ontario, from Grades 3 to 9.¹ Our goal is to shed light on how a student's self-perception in math relates to that student's actual performance over time. Does believing in your math abilities lead to better academic results, or is it the other way around?

Method

To explore this relationship, we analyzed data from 22 066 English-language students who participated in the mathematics components of the Grade 3 and Grade 6 EQAO assessments in 2013 and 2016 and in the Grade 9 Assessment of Mathematics in the academic stream in 2019.²

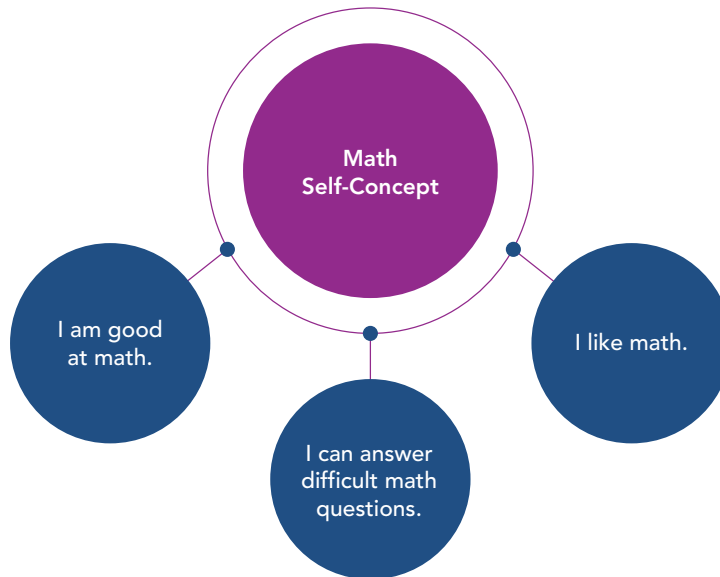
At each assessment point, students were asked to express their level of agreement with the following three statements: (1) "I am good at math," (2) "I can answer difficult math questions" and (3) "I like math." These responses provided valuable insights into students' math self-concept at each grade, as depicted in **Figure 1**.

¹ This research brief aims to simplify the language, remove technical details and emphasize the practical implications of the research findings for the education community. The full research report is under review for publication in an academic journal.

² The analysis was conducted separately by academic and applied stream, as the streams for the EQAO Grade 9 Assessment of Mathematics were separate in 2019. Since close to 80% of the students in this cohort were in the academic stream, this research brief reports mainly on findings for these students.

To uncover the intricate relationship between math self-concept and math achievement, we used a statistical technique that allows us to examine how changes in students' math self-concept during earlier grades are related to changes in their math achievement in later grades, and vice versa.³ This analysis helps us understand the direction and strength of the relationship between students' math self-concept and their math achievement.

Figure 1. Assessing Student Math Self-Concept



Key Findings

Our study revealed an intriguing finding: a reciprocal, rather than a unidirectional, relationship between math self-concept and math achievement from Grade 3 to Grade 9. In essence, how students perceive themselves as math learners influences how well they do in math; and in turn, how well they do in math also influences how they perceive themselves as math learners.

Figure 2 visually represents this two-way relationship. The arrows in the figure indicate the directions of influence, and the varying arrow sizes and the numbers represent the strength of these influences.

The orange arrows show the significant impact of earlier math achievement on later math self-concept. A student's positive performance in math at an earlier grade has a considerable influence on the student's self-perception in the subject later.

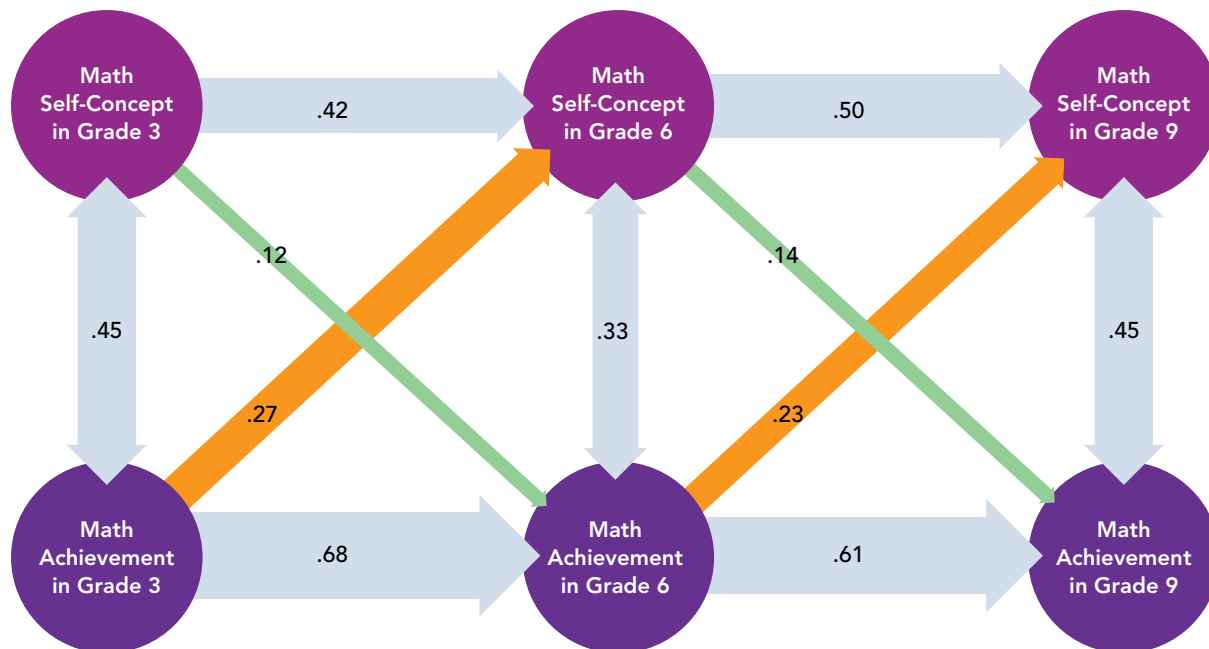
Similarly, the green arrows emphasize the influence of earlier self-concept on later math achievement. Students' positive self-concept formed in a younger grade plays a meaningful role in shaping their math performance in subsequent years, although the strength of the relationship is weaker.

In summary, our findings demonstrate that both higher achievement in an early grade and positive self-concept formed during earlier years contribute to improved math outcomes in later years. This means that as students do well in math, they become more confident in their abilities, and this increased self-belief, in turn, contributes to even better math performance over time. In other words, success in math and self-confidence create a cycle with each continuously reinforcing and strengthening the other throughout the student's academic journey.⁴

³ This technique is called autoregressive cross-lagged panel modelling.

⁴ Findings for students in the applied stream generally followed the same pattern as the academic stream but showed weaker effects.

Figure 2. Direction and Strength of the Influence Between Math Self-Concept and Math Achievement



Implications

The reciprocal relationship between math self-concept and math achievement highlights the importance of holistic approaches and early interventions in both the cognitive and the psychological aspects of education. To ensure students reach their full potential and promote equitable outcomes in education, it is essential to address not only academic skills but also students' beliefs about their abilities.

In particular, interventions in early elementary years that focus on enhancing math self-concept may have substantial positive effects on students' future math achievement in the long term.

Key Take-Aways

- **Empowering students' beliefs:** Encouraging students to develop a positive perception of their math skills can boost their overall academic performance. By nurturing their self-confidence and emphasizing their strengths, we can instill a passion for math and enhance their overall learning experience.
- **Targeted interventions:** It is crucial to identify not only students with low math achievement but also those with low math self-concept. Providing targeted support and interventions can be transformative in improving their academic performance. One effective approach to support students with low math self-concept is fostering a growth mindset, where students believe that they can develop their abilities through effort and practice. For instance, educators can encourage students to view challenges as opportunities to learn and grow, praising their efforts and perseverance rather than solely focusing on performance. This positive mindset can help students overcome obstacles, build confidence and unlock their full potential in math and beyond.
- **Parental involvement:** Parents play a crucial role in shaping their children's beliefs about their math ability. Creating a supportive and encouraging environment at home can significantly contribute to a positive math self-concept in students. Parental involvement in a child's education fosters a lifelong love for learning and enhances chances of academic success.

Conclusion

Our research underscores the crucial role of early math self-concept in shaping students' academic achievements. By understanding the reciprocal relationship between beliefs and performance, educators, parents and policy-makers can adopt targeted strategies to foster positive self-concepts and promote academic success. Together, let's empower students to embrace their potential, to build confidence in their abilities and to embark on a journey of lifelong learning.