Estimating the Impact of Growth Mindset on High School Mathematics Performance and Course-taking

BY SOOBIN KIM

Prior research has shown that successful completion of advanced mathematics courses has positive effects on four-year college enrollment, wages, and health indicators.[1,2,3,4,5,6,7] Acknowledging these benefits, many states and school districts have initiated programs to improve mathematics course-taking patterns and educational attainment.[8,9]

In most states, high school students are required to take three or four years of mathematics. In 9th grade, students who are taking Algebra I are considered on track to complete Algebra II or Pre-Calculus by the end of high school, courses which are generally considered the threshold for college admission. Table 1 serves as a reference for common 9th grade mathematics courses and their indication in terms of college preparation.

Table 1. Mathematics Courses in 9th grade and college preparation

COURSE	INDICATION
Basic or General Math	Lower-level
Pre-Algebra	Lower-level
Algebra I	On-track
Geometry	Advanced
Algebra II	Advanced

One approach to increasing advanced mathematics course-taking that remains underexplored is the development of students' growth mindsets.[10,11,12,13] This study evaluated the causal effects of a brief online program designed to foster a growth mindset and explored whether and how students' prior academic performance and school context were related to the success of the program.

STUDY DESIGN

The National Study of Learning Mindsets (NSLM) was specifically designed to understand which kinds of 9th grade students, in which kinds of classrooms and in which kinds of

KEY FINDINGS

- After participating in the growth mindset program used in the National Study of Learning Mindsets, students' mathematics grade point average (GPA) in 9th grade increased by an average of 0.05 points on a 4.3-point scale.

- Effects of the program on mathematics GPA were larger among two groups: a) students taking advanced courses in 9th grade (Geometry or Algebra II) and b) students taking Algebra I in 9th grade with a relatively high incoming mathematics GPA.

- At schools where growth mindset increased for students in the control group, students who participated in the growth mindset program experienced more improvement in their GPAs.

SAMPLE

This study leverages data from the National Study of Learning Mindsets (NSLM), the largest-ever randomized controlled trial of a growth mindset program in the U.S. in K-12 settings, in which a brief online growth mindset program was administered to 9th grade students during the 2015-2016 academic year. The NSLM features a nationally representative probability sample of regular U.S. public high schools. Additional information about the NSLM sample of schools and students can be accessed here. This study restricts the sample to individuals who participated in the post-growth mindset program survey and schools that provided administrative data. The final sample includes 13,660 students from 65 schools.

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schools, are most likely to benefit from the growth mindset program. The current project furthered this goal by exploring the variation of the program's effects across school contexts and student characteristics.

In the NSLM, students were randomly assigned to complete either the growth mindset program or a control activity during two 25-minute sessions. In the growth mindset program, students read and listened to materials describing scientific evidence about how the brain works and why people can grow their intellectual abilities over time. The program encouraged students to think about why they might want to grow their brain in order to make a difference on something that matters to them, such as their family, community, or a social issue they care about.

This study estimated the impact of a growth mindset program on outcomes related to students' mathematics course-taking, such as grade point average (GPA) and course enrollment, and examined how effects differed based on students' incoming (8th grade) mathematics GPA, the intensity of the mathematics course in which a student was enrolled, and school context related to growth mindset.

Before exploring the effects of the growth mindset program used in the NSLM, the researchers analyzed how a growth mindset predicts students' 9th grade mathematics course-taking in general. Results, although correlational, indicated that students who had more of a growth mindset completed higher levels of mathematics in 8th grade. In addition, students with stronger self-reported growth mindset were more likely to move up to Geometry in 9th grade after taking Algebra I in 8th grade. In other words, growth mindset was positively related to advanced mathematics course-taking and likelihood of on-time progression through mathematics course levels.

With this information, the researchers proceeded to study the causal effects of the growth mindset program on mathematics GPA, to gain a more complete picture of the relationship between growth mindset and mathematics performance.

Key Findings

After participating in the growth mindset program used in the National Study of Learning Mindsets, students' mathematics GPA increased by an average of 0.05 points on a 4.3-point scale.

The program effects were positive and significant for mathematics, science, and STEM courses, whereas the effects were smaller and insignificant for English and social science courses. The effect size for mathematics GPA was 0.05 points on a 4.3-point scale. Science and mathematics were the subjects in which students improved the most after participating in the growth mindset program.

Effects of the program on mathematics GPA were larger among two groups: a) students taking advanced courses in 9th grade (Geometry or Algebra II) and b) students taking Algebra I in 9th grade with a relatively high incoming mathematics GPA.

The program effects were positive and statistically significant for these two groups, whereas the effects were smaller and insignificant for lower-level and on-track courses, including Pre-Algebra and Algebra I. Results also indicated that the growth mindset program was effective among students with higher 8th grade standardized mathematics test scores, and that effects were minimal for students with lower 8th grade standardized mathematics test scores taking Algebra I in 9th grade.

These results should be considered alongside previous findings that the mindset treatment was more effective for lower-achieving students: for example, Yeager et al. (2019), using the same NSLM data, found that the mindset treatment improved grades among lower-achieving students and increased overall enrollment in advanced mathematics courses. However, it is important to note that Yeager and colleagues defined lower achievement differently. They assigned students with 8th grade GPAs below the mean GPA of students at their school prior to the random assignment as lower-achieving, whereas in the current study, the researchers defined achievement level according to students' mathematics test scores within each mathematics class (students with 8th grade mathematics test scores in the lowest quintile were defined as lower-achieving). Thus, these two findings are not necessarily in conflict.

At schools where growth mindset increased for students in the control group, students who participated in the program experienced more improvement in their GPAs.

To get a sense of school context related to growth mindset, the researchers measured the fraction of control group students who did not participate in the growth mindset program but nevertheless experienced an increase in self-reported growth mindset. The hypothesis behind this measure is that, because students were surveyed in 9th grade, when the vast majority of students are attending a new school, an increase of growth mindset among control group students may be related to many factors including being immersed in school climate that emphasizes and supports the development of a growth mindset, certain pedagogical or curricular approaches, or being surrounded by peers who support growth mindsets. In this measure, the researchers only considered schools that implemented the growth mindset program early in the academic year, where survey data would most closely match the timing of students' transition to a new school.

Results indicated that at schools where a larger fraction of control students showed increases in growth mindset *without* participating in the growth mindset program, students who *did* participate in the program showed above-average GPA improvement—a finding which requires further investigation to study other factors that may enhance the effects of growth mindset programs.

INSIGHTS AND FUTURE DIRECTIONS

This study suggests that the growth mindset program was modestly effective in terms of GPA improvement for students who were taking advanced mathematics courses and who had higher incoming mathematics GPA. Findings also indicated that school context around growth mindset was related to the success of the program. This suggests that schools and policymakers may think about enhancing students' growth mindset through improvement to the learning environment and school norms as a whole, which may amplify the positive effects of programs that are specifically targeted at developing growth mindset. For future work, the researchers will use 10th grade course-taking information to estimate whether the mindset program helped students be on-track in terms of college trajectories and whether the mindset program led to more pro-academic course-taking patterns and better outcomes, especially among students from families facing economic disadvantage.

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