Effects of Early Acceleration of Students in Mathematics on Mathematics Coursework

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Can an early start in advanced mathematics coursework (early acceleration of students in mathematics) enhance the likelihood that students take pre-calculus and calculus in high school (the most advanced mathematics courses in school mathematics)? One of the most distinct characteristics of school mathematics is its sequential structure. Access to mathematics courses is determined by prior success in prerequisite courses that systematically control students' progress in mathematics coursework. Spring (1989) emphasized that the timing of taking a particular mathematics course can function as a critical gateway in the successful learning of mathematics. Early acceleration of students into formal algebra is perhaps the most critical issue in mathematics coursework, because as the basis for academic mathematics and science courses, formal algebra is the first major gateway that controls students' subsequent coursework in school mathematics and science.

Researchers, however, do not agree on whether students can benefit from early access to advanced mathematics courses. Advocates of early acceleration in mathematics believe in the sequential nature of mathematics, and they argue that early acceleration of students provides them with greater opportunities and potentials to pursue further mathematics courses. Opponents of early acceleration in mathematics believe in the selective nature of mathematics, and they argue that early acceleration should be limited to selected mathematically gifted students and early acceleration of ordinary students frustrates and alienates them for further mathematics courses. Taking the middle ground in this debate, other researchers appreciate the idea of early acceleration of students in mathematics but worry about the consequences of early acceleration in mathematics. Their concern is whether students can become too exhausted both physically and mentally to pursue the most advanced mathematics courses (pre-calculus and calculus) in high school, once they are accelerated early into advanced mathematics in middle school.

The present study aimed to investigate early acceleration of students as a common instructional practice in mathematics education, particularly for academically gifted students, as it impacts the participation of students in the traditional mathematics course sequence (specifically, taking pre-calculus and calculus, the most advanced coursework in the traditional mathematics course sequence). Operationally, students were classified into gifted, honors, and regular students, based on their mathematics achievement, and within each group, students were considered accelerated, if they took formal algebra in either grade 7 or grade 8. Two main research questions were addressed in the present study, and these research questions were examined for gifted, honors, and regular students.

1. How likely do students take pre-calculus and calculus in high school, if they are accelerated early into formal algebra, in comparison with those who are not accelerated early into formal algebra?

2. What student and school characteristics influence the likelihood that students take pre-calculus and calculus in high school, once they are accelerated early into formal algebra, in comparison with those who are not accelerated early into formal algebra?

Analysis was based on data from the Longitudinal Study of American Youth (LSAY), a national six-year panel study of mathematics and science education in public middle and high schools in the United States. About 60 seventh graders were randomly selected from a nationally

stratified probability sample of 52 middle and high schools across the United States (N = 3,116). These students were then followed throughout their entire middle and high school grades from 7 to 12. A number of student-level variables were used to predict mathematics coursework in high school, including gender, race, age, number of parents, number of siblings, parent education, parent socioeconomic status (SES), and home language. Two groups of school characteristics were used to predict mathematics coursework in high school. One group contained variables often referred to as school contextual variables, including school enrollment size, school location, school socioeconomic composition, school racial composition, grade span, student-teacher ratio, teacher education level, teacher experience in mathematics, and computer-student ratio. The other group of school characteristics contained variables often referred to as school climatic variables, including academic pressure, disciplinary climate, parental involvement, principal leadership, teacher autonomy, teacher commitment, staff cooperation, mathematics homework, general support for mathematics, and extracurricular activities.

Hierarchical linear modeling (HLM) was employed as the primary statistical technique (Raudenbush & Bryk, 2002). Because outcome variables were dichotomous and students were nested within schools, two-level logistic HLM models were required for the present study, as outlined in Raudenbush and Bryk (2002). Non-accelerated gifted students were unlikely to take calculus in high school. Both non-accelerated honors and regular students were unlikely to take either pre-calculus or calculus in high school. There were more incidences of statistically significant variance among schools in the average probability of taking advanced mathematics coursework for accelerated students than non-accelerated students. For both accelerated gifted and honor students, their schools showed statistically significant variance in both pre-calculus and calculus. For non-accelerated regular students, their schools showed statistically significant variance in pre-calculus.

When gifted students were accelerated, Asian students (at the student level) and students in schools with greater general support for mathematics (at the school level) were more likely to take calculus in high school. When gifted students were not accelerated, students with high mother SES (at the student level) were more likely to take calculus in high school. When honors students were accelerated, students with home language other than English (at the student level) as well as students in small schools, students in schools with a small portion of minority students, students in schools with a low student-teacher ratio, and students in schools where more students shared a computer for mathematics education (at the school level) were more likely to take pre-calculus in high school. When honors students were not accelerated, Asian students, students from large families, students with higher father education, and students with high mother SES (at the student level) were more likely to take pre-calculus in high school. When honors students were accelerated, students in schools with more teacher autonomy (at the school level) were more likely to take calculus in high school. When honors students were not accelerated, students from both-parent families and students with higher father education (at the student level) were more likely to take calculus in high school. When regular students were not accelerated, Asian students, younger students, and students with higher mother education (at the student level) as well as students in schools with more mathematics homework and students in schools with more general support for mathematics education (at the school level) were more likely to take pre-calculus in high school. When regular students were accelerated, male students (at the student level) were more likely to take calculus in high school. When regular students were not accelerated, male students, Asian students, and students with high mother SES (at the student level) were more likely to take calculus in high school.

REFERENCES

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