

Associations between the qualifications of middle school Algebra I teachers and student math achievement

Success in advanced math courses gives students access to a wider variety of college and career options. Because students who fail Algebra I are less likely to enroll and succeed in advanced math courses, it is considered a gateway course for advanced math. To increase the opportunity to take more-advanced math courses in high school, there has been a trend toward enrolling students in Algebra I in middle school. That has created a need for middle school teachers with more-advanced knowledge of math content.

The current study examined associations between the qualifications of middle school Algebra I teachers (certifications to teach math, education background, and performance on certification exams) and their students' Algebra I achievement. The qualifications most strongly associated with middle school students' Algebra I achievement were teacher performance on math certification exams and years of experience teaching math. The study also found that teacher performance on math certification exams and years of experience teaching math were also strongly associated with Algebra I achievement for students in under-represented subgroups (Black students and Hispanic students) and disadvantaged subgroups (students receiving special education services and students eligible for the national school lunch program).

Why this study?

Historically, students took Algebra I in high school, but there has been a rising trend toward taking it in middle school. Enrollment in Algebra I or more-advanced math courses doubled over the past two decades.¹ Students who take and pass Algebra I are more likely to take and pass more-advanced math courses in high school.² Success in advanced math courses gives students access to a wider variety of college and career options.³ The trend toward taking Algebra I in middle school has created a need for middle school teachers with more-advanced knowledge of math content, because prior research suggests that teachers' knowledge of math content plays an important role in students' math achievement.⁴

1. Domina, T. (2014). The link between middle school mathematics course placement and achievement. *Child Development*, 85(5), 1948–1964. <https://eric.ed.gov/?id=EJ1039375>.
2. Snipes, J., & Finkelstein, N. (2015). *Opening a gateway to college access: Algebra at the right time* (Research Brief). San Francisco, CA: Regional Educational Laboratory West at WestEd. Retrieved August 28, 2019, from <https://www.wested.org/resources/algebra-at-the-right-time/>.
3. National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel*. Washington, DC: U.S. Department of Education. Retrieved August 28, 2019, from <https://www2.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf>.
4. National Mathematics Advisory Panel. (2008). *Foundations for success*.

What was studied and how?

The study focused on teachers' certifications to teach math, education background, and performance on certification exams, particularly those associated with math content knowledge. The study addressed the following questions:

- What are the qualifications (certifications to teach math, education background, and certification exam scores) of middle school Algebra I teachers in Missouri?
- Which teacher qualifications are most strongly associated with student performance on the Algebra I Missouri Assessment Program (MAP) End-of-Course (EOC) exam?
- How do specific teacher qualifications relate to achievement on the Algebra I MAP EOC exam for students in under-represented subgroups (Black students and Hispanic students) and disadvantaged subgroups (students receiving special education services and students eligible for the national school lunch program)? In particular, which qualifications are most strongly associated with success for students in these subgroups?

Descriptive statistics (percentages, counts, and means) were used to address the first research question on teacher qualifications. The second and third questions were addressed using data on student, teacher, and district characteristics to estimate a regression model⁵ on the relationship between teacher qualifications and student achievement on the Algebra I MAP EOC exam. The district- and school-level information, as well as student grade-level MAP pretest scores, enabled estimating this relationship while accounting for differences in prior student achievement and for other differences among schools and districts in the study.

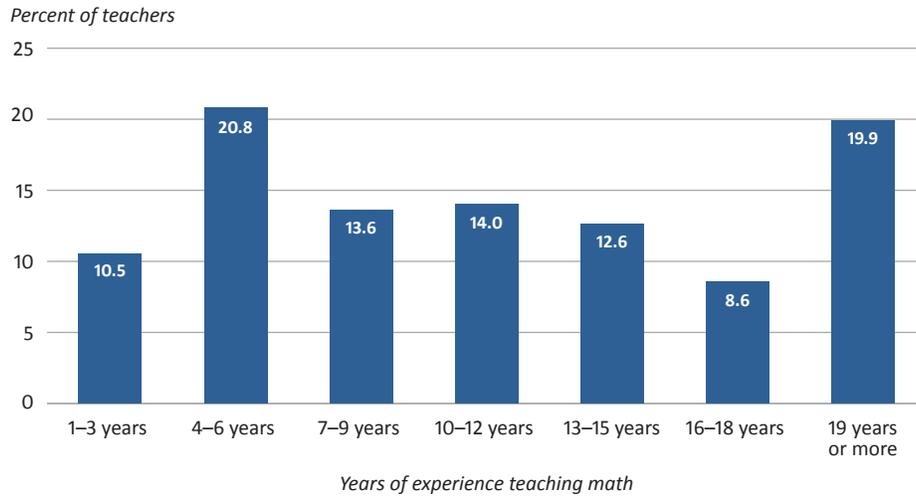
The sample consisted of all middle school Algebra I teachers in Missouri during the 2015/16 school year: 429 teachers across 276 schools and 204 districts. The schools were in urban ($n = 45$), suburban ($n = 70$), town ($n = 54$), and rural ($n = 107$) locales. Teachers were linked to 11,708 middle school students who took Algebra I during the 2015/16 academic year (712 students in grades 7 and 10,996 in grades 8). Students in under-represented subgroups made up 12 percent of the sample: 7 percent ($n = 785$) of students were Black, and 5 percent ($n = 530$) were Hispanic. Students in disadvantaged subgroups made up 27 percent of the sample: 26 percent ($n = 3,073$) of students were eligible for the national school lunch program, and 1 percent ($n = 120$) were receiving special education services.

Findings

- **Roughly 40 percent of middle school Algebra I teachers held a certification that allowed them to teach content beyond Algebra I.** All teachers in the sample were certified in math, with 60 percent possessing a middle school math certification, allowing them to teach math courses up to Algebra I. A smaller share of teachers (40 percent) held a high school math certification, allowing them to teach math courses through grade 12. High school certifications require more-advanced math content knowledge because teachers need to be prepared to teach courses such as trigonometry and calculus.
- **More than 40 percent of teachers had either 4–6 or 19 or more years of experience teaching math.** Experience teaching math among the teachers in the sample ranged from 1 to 29 years. The two most frequently observed categories were teachers with 4–6 years of experience teaching math (21 percent) and teachers with 19 or more years of experience teaching math (20 percent; figure 1).
- **The most frequently taken exam in the certification process was the Praxis II Middle School Mathematics exam, which most teachers passed.** About 53 percent of teachers ($n = 228$) took the Praxis II Middle School Mathematics exam during their certification process. About 96 percent achieved a passing score (figure 2). Teachers could take the exam multiple times, and teachers who did not pass might have received a passing score on another math certification exam.

5. A type of regression model was estimated that forces some coefficients to be zero, thereby selecting only the most predictive covariates to have nonzero coefficients. All predictor variables were standardized to z-scores before the regression model-fitting procedure was run. Only variables with a nonzero coefficient in at least one model are reported.

Figure 1. Among middle school Algebra I teachers in Missouri in 2015/16, the two largest categories of years of experience teaching math were 4–6 years and 19 or more years

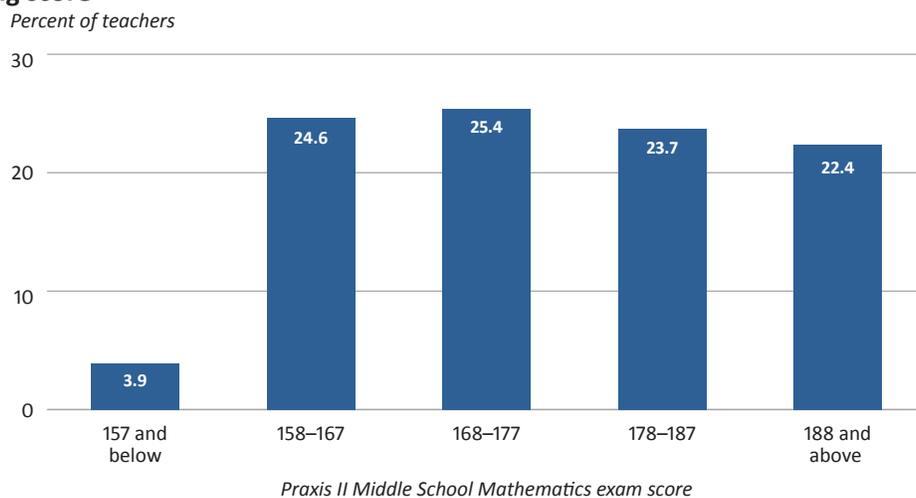


Note: $n = 428$. One teacher was omitted from the analysis because of missing data on years of experience teaching math.

Source: Authors' calculations based on data provided by the Missouri Department of Elementary and Secondary Education.

- **The second most frequently taken exam in the certification process was the Praxis II Mathematics: Content Knowledge exam, which most teachers passed.** About 25 percent of teachers ($n = 108$) took the Praxis II Mathematics: Content Knowledge exam during their certification process. About 83 percent achieved a passing score. Teachers could take the exam multiple times, and teachers who did not pass might have received a passing score on another math certification exam.
- **The teacher qualification most strongly associated with Algebra I achievement for all middle school students was performance on math certification exams, followed by years of experience teaching math.** Overall, the teacher qualification with the strongest association with middle school students' Algebra I achievement was performance on the Praxis II Middle School Mathematics exam. Years of experience teaching math had the

Figure 2. Most teachers in Missouri in 2015/16 who took the Praxis II Middle School Mathematics exam achieved a passing score



Note: $n = 228$. A passing score is 158 or higher on a scale of 100–200.

Source: Authors' calculations based on data provided by the Missouri Department of Elementary and Secondary Education.

second strongest association, and performance on the Praxis II Mathematics exam had the third strongest association.

- **Teacher performance on at least one math certification exam was strongly associated with middle school students' Algebra I achievement for students in each of the under-represented and disadvantaged subgroups.** Performance on the Praxis II Middle School Mathematics exam was the qualification most strongly associated with Algebra I achievement for students receiving special education services and students eligible for the national school lunch program. Performance on the Praxis II Mathematics: Content Knowledge exam (which covers knowledge of high school math) was more strongly associated with Algebra I achievement for Black students than was the Praxis II Middle School Mathematics exam. Performance on the Missouri Educator Gateway Assessments Middle School Education: Mathematics exam was associated with Algebra I achievement for Hispanic students.
- **Years of experience teaching math was strongly associated with middle school students' Algebra I achievement for Hispanic students and students eligible for the national school lunch program.** For Hispanic students the expected gain for each additional year of teacher experience was similar across the range of teacher experience. For students eligible for the national school lunch program, each additional year of teacher experience was associated with a greater expected gain in student Algebra I achievement.

Implications

Teacher performance on a math certification exam was the qualification most strongly associated with middle school students' Algebra I achievement, as measured by scores on the Algebra I MAP EOC exam, both for students overall and for students in under-represented and disadvantaged subgroups. These results suggest that gateway assessments may meaningfully differentiate a teacher's ability to support middle school students' success through Algebra I. Policymakers and state and local education administrators may want to consider teachers' performance on certification exams when determining minimum qualifications for teaching Algebra I.

Middle school students whose teachers had more years of experience teaching math tended to perform better on the Algebra I MAP EOC exam. This result held true for Hispanic students and students eligible for the national school lunch program. When selecting Algebra I teachers, schools and districts—especially those with large populations of under-represented or disadvantaged students—might give preference to more experienced teachers.

Unlike prior research, this study did not find positive links between teacher certification levels and student achievement in math, after student and school characteristics and other teacher qualifications were accounted for. In particular, teacher qualifications to teach courses beyond the middle grades (teachers with a high school math certification) were not associated with students' Algebra I achievement. Further research is needed to determine whether other teacher qualifications are more strongly associated with middle school students' Algebra I achievement.

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Stewart, J., Rhoads, C., Serdiouk M., Van Dine, D., Cherasaro, T., & Klute, M. (2019). *Associations between the qualifications of middle school Algebra I teachers and student math achievement* (REL 2020–005). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Central. Retrieved from <http://ies.ed.gov/ncee/edlabs>.