IES Institute of Education Sciences

STUDY BRIEF
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Regional Educational Laboratory Central
At Marzano Research

What Grade 7 Foundational Knowledge and Skills Are Associated with Missouri Students' Algebra I Achievement in Grade 8?

To increase opportunities for students to take more advanced math courses in high school, many school districts enroll grade 8 students in Algebra I, a gateway course for advanced math. But students who take Algebra I in grade 8 and skip other math courses, such as grade 8 general math, might miss opportunities to develop the foundational knowledge and skills required for success in advanced math courses. This leaves educators to determine which students are ready for Algebra I in grade 8 and which are not. To inform strategies that address this challenge, this study examined whether student knowledge in five math domains in grade 7 was associated with Algebra I achievement in grade 8. It found that students' scores in all five domains were associated with Algebra I achievement. The *expressions and equations* domain had the strongest association. The association between the *number system* domain and Algebra I achievement was stronger for English learner students than for non–English learner students. The associations between the five grade 7 domains and Algebra I achievement did not significantly differ for students who were receiving special education services and those who were not.

Why this study?

Increasing numbers of students are enrolling in Algebra I in middle school in order to take more advanced math courses in high school,[1] including about 20 percent of grade 8 students in Missouri.[2] But students who take Algebra I in grade 8 and skip other math courses, such as grade 8 general math, might miss opportunities to build the foundational knowledge and skills needed to perform well in Algebra I.[3] To inform strategies that address this concern, the Regional Educational Laboratory Central—in partnership with the Missouri Department of

1. Star, J. R., Caronongan, P., Foegen, A., Furgeson, J., Keating, B., Larson, M. R., … Zbiek, R. M. (2015). *Teaching strategies for improving algebra knowledge in middle and high school students* (NCEE 2015-4010). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance. https://eric.ed.gov/?id=ED555576.
2. Data Recognition Corporation. (2016). *Missouri Assessment Program grade-level assessments: Grades 3–8 English language arts and mathematics* (Technical report). Jefferson City, MO: Missouri Department of Elementary and Secondary Education. Retrieved June 19, 2019, from https://dese.mo.gov/sites/default/files/asmt-gl-2016-tech-report-ela-and-math.pdf. Data Recognition Corporation. (2017). *Missouri Assessment Program grade-level assessments: Guide to interpreting results; Summative assessments: English language arts, mathematics, and science.* Jefferson City, MO: Missouri Department of Elementary and Secondary Education. Retrieved June 19, 2019, from https://dese.mo.gov/sites/default/files/asmt-gl-gir-spring-2017.pdf. Missouri Department of Elementary and Secondary Education. (2015). *ESEA flexibility request.* Jefferson City, MO: Author. Retrieved June 19, 2019, from https://dese.mo.gov/sites/default/files/qs-MO-2015-ESEA-Waiver-Renewal-FINAL.pdf. Missouri Department of Elementary and Secondary Education. (2016). *Online End-of-Course Assessments: Guide to interpreting results 2016–2017.* Jefferson City, MO: Author. Retrieved June 19, 2019, from https://dese.mo.gov/sites/default/files/asmt-eoc-gir-1617.pdf.
3. Domina, T., McEachin, A., Penner, A., & Penner, E. (2015). Aiming high and falling short: California's eighth-grade Algebra-for-All effort. *Educational Evaluation and Policy Analysis, 37*(3), 275–295. https://eric.ed.gov/?id=EJ1072750. Pillay, H., Wilss, L., & Boulton-Lewis, G. (1998). Sequential development of algebra knowledge: A cognitive analysis. *Mathematics Education Research Journal, 10*(2), 87–102. https://eric.ed.gov/?id=EJ578282.

Elementary and Secondary Education—conducted this study on the association between scores in the five math domains assessed by the 2016/17 Missouri Assessment Program in grade 7 and Algebra I achievement in grade 8.

The Missouri Department of Elementary and Secondary Education has not issued guidelines for determining which students are ready to enroll in Algebra I in grade 8, so approaches vary across the state. By examining the association between math domain scores in grade 7 and Algebra I achievement in grade 8, this study provides information that might help Missouri educators distinguish students who are ready for Algebra I from students who need more support before enrolling.

What was studied and how?

The study examined associations between scores in the five math domains of the 2016/17 Missouri Assessment Program in grade 7 (ratios and proportional relationships; the number system; expressions and equations; geometry; and statistics and probability) and scale scores on the Algebra I End-of-Course Assessment in grade 8. It addressed three research questions:

1. To what extent are scores in the five math domains associated with Algebra I achievement?

2. How do the associations vary by English learner status?

3. How do the associations vary by special education status?

The study used administrative data from the Missouri Department of Elementary and Secondary Education. The sample included 11,298 students who took the Algebra I End-of-Course Assessment in grade 8 at the end of the 2017/18 school year and had grade 7 assessment data with domain scores available for the 2016/17 school year. Multilevel regression models were fit that account for the likelihood that students in the same schools or districts were more similar to one another than they were to students in other schools or districts. The models examined the association between each math domain score and Algebra I achievement above and beyond the association of the other four domains.

The associations are discussed for two types of variables: standardized and unstandardized. Standardized variables allow for easier comparison across the five math domains of the Missouri Assessment Program by indicating the standard deviation change in scale score on the Algebra I End-of-Course Assessment that would be expected from a one standard deviation change in score in each domain. Unstandardized variables help in interpreting the findings by maintaining the original scale of the assessment score. With unstandardized variables, the association is described as the number of points a student's Algebra I End-of-Course Assessment scale score would be expected to change with each additional question answered correctly in a particular domain. To add further perspective, the report presents the change in the actual scale score on the Algebra I End-of-Course Assessment as a percentage of the score range for the basic and proficient achievement levels of the assessment.

Findings

- *On average, the students in the study sample scored in the advanced range on the Algebra I End-of-Course Assessment.* The average scale score on the Algebra I End-of-Course Assessment was about 412 (with a standard deviation of 12.7), which is in the point range (a score of 409 or higher) of the advanced achievement level. This average score is likely due to some districts and schools placing only the most advanced students in Algebra I in grade 8.
- *Scores in all five math domains in grade 7 were associated with Algebra I achievement in grade 8; the expressions and equations domain had the strongest association.* The score in each math domain in grade 7 was

independently associated with Algebra I achievement in grade 8, above and beyond the associations of scores in the other four domains. The strongest association was for the expressions and equations domain. Getting an additional 3 items correct of that domain's 13 items while scores in the other four math domains stay the same is associated with scoring 2.8 points higher on the Algebra I End-of-Course Assessment in grade 8. That is more than a quarter of the point range of the basic achievement level and the proficient achievement level. The students in the study sample were, on average, quite advanced in their math skills. The relative associations between math domain scores and Algebra I achievement might have differed if a larger sample with a wider range of achievement had been used.

- *The association between the number system domain and Algebra I achievement was stronger for English learner students than for non–English learner students.* When the strength of the associations between math domain scores in grade 7 and Algebra I achievement in grade 8 was compared for English learner students and non–English learner students, the only statistically significant difference was for the number system domain. The association was about twice as strong for English learner students. So, for English learner students, getting an additional two items correct of that domain's eight items while scores in the other four math domains stay the same is associated with scoring 4.1 points higher on the Algebra I End-of-Course Assessment in grade 8, which is more than a third of the point range of the basic and proficient achievement levels. In contrast, for non–English learner students, getting an additional two items correct is associated with scoring 2.0 points higher, which is about a fifth of the point range of the basic and proficient achievement levels. The sample used for this study was not ideal for investigating whether associations differ by English learner status because it included only a small number of English learner students (228). Further analyses, preferably with a larger sample of English learner students, are needed to support the generalizability of these findings.
- *The associations between the five grade 7 domains and Algebra I achievement did not significantly differ for students who were receiving special education services and students who were not.* The sample used for this study was not ideal for investigating whether associations differ by special education status because it included only a small number of students who were receiving special education services (170). Further analyses, preferably with a larger sample of students receiving special education services, are needed to support the generalizability of these findings.

Implications

The study findings suggest that Missouri educators might consider adding math domain scores on the Missouri Assessment Program in grade 7, particularly the expressions and equations domain, to the factors they use in determining whether students are ready to take Algebra I in grade 8. Educators might also find the results useful in developing processes for districts to identify students who need additional support to acquire the foundational knowledge and skills most strongly associated with Algebra I achievement. While the findings suggest that instruction in all the domains examined is important, instruction in the expressions and equations domain may be particularly key to preparing students for Algebra I. Thus, educators might use the findings to provide targeted instruction to prepare students to take Algebra I in middle school.

Educators may consider the findings particularly useful because the study relied on data from an assessment that nearly all Missouri students take in grade 7 rather than an additional assessment such as an Algebra I readiness test. The findings are similar to those of previous research that relied on assessments specifically designed to measure Algebra I readiness.[4]

4. Huang, C.-W., Snipes, J., & Finkelstein, N. (2014). *Using assessment data to guide math course placement of California middle school students* (REL 2014–040). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory West. Retrieved June 19, 2019, from https://ies.ed.gov/ncee/edlabs/projects/project.asp?ProjectID=345.

That the number system domain had a stronger association with Algebra I achievement for English learner students than for non–English learner students suggests that Missouri educators might want to pay particular attention to this domain when determining whether English learner students are ready to take Algebra I in grade 8. The study did not provide information that can explain why the association between that domain and Algebra I achievement was stronger for English learner students, but it may be in part because the domain contains a smaller proportion of contextual items, which require students to read and interpret situations before conducting math calculations, than the other math domains do.

Future research could examine patterns of advanced math coursetaking and achievement among students predicted to be ready to take Algebra I in middle school based on their math domain scores in grade 7 as well as among students predicted not to be ready. In addition, educators in other states might wish to conduct similar analyses of the association between domain scores on their state assessments in grade 7 and Algebra I achievement in grade 8.

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Klute, M., Dougherty, B., & Van Dine, D. (2020). *What grade 7 foundational knowledge and skills are associated with Missouri students' Algebra I achievement in grade 8?* (REL 2020–023). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Central.