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Algebra I and College Preparatory Diploma Outcomes among Virginia Students Who Completed Algebra I in Grades 7–9

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Algebra I and College Preparatory Diploma Outcomes among Virginia Students Who Completed Algebra I in Grades 7–9

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Education leaders in Virginia use early access to Algebra I as one method to provide students more time to take college preparatory courses in high school, thereby increasing students' likelihood of graduating prepared for college and careers. Yet, little data are available for these leaders to examine whether their approach is warranted. Members of the Regional Educational Laboratory Appalachia Student Success in Mathematics partnership are interested in learning more about students who complete Algebra I in grades 7–9 and their outcomes. This study examined whether these students passed the Algebra I state assessment and whether they earned a college preparatory diploma. The study used administrative data to calculate descriptive statistics for one cohort of Virginia grade 5 students who completed Algebra I in grades 7–9. The results for the overall study population are presented by students' proficiency level on the grade 5 math state assessment and disaggregated for economically disadvantaged students and English learner students.

Among students in the overall study population who scored at the advanced proficient level in grade 5 math and completed Algebra I in grade 7, 90 percent passed Algebra I, and 80 percent earned a college preparatory diploma. The percentage of economically disadvantaged students who passed Algebra I was 10 percentage points lower than the percentage of the overall study population, and the percentage who earned a college preparatory diploma was 18 percentage points lower. There were similar differences in performance for students who completed Algebra I in grade 8 or 9. The study findings suggest the need to better understand Algebra I placement policies and practices and whether they unintentionally contribute to differences in student access to Algebra I and subsequent outcomes.

Why this study?

Education leaders in Virginia use early access to Algebra I as one method to increase students' likelihood of graduating from high school prepared for college and careers. Studying Algebra I in middle school is intended to offer students the opportunity to take more advanced math courses in high school, with the aim of increasing the number of students who graduate with a college-ready diploma (Allensworth & Easton, 2005, 2007; Matthews & Farmer, 2008; Watson & Carlivati McCarroll, 2010). However, these outcomes are not always realized. Thus, members of the Regional Educational Laboratory Appalachia Student Success in Mathematics partnership are interested in learning more about students who complete Algebra I in grades 7–9 and their outcomes. Of particular interest are outcomes for economically disadvantaged students, who represent a large percentage of the students whom those leaders serve, and for English learner students, who represent a growing percentage of the students they serve. On average, these populations have not achieved the same high school outcomes as the overall population. In 2019, 52 percent of Virginia high school graduates overall earned a college preparatory diploma compared with 31 percent of economically disadvantaged graduates and 15 percent of English learner graduates (Virginia Department of Education, n.d. d).

For additional information, including technical methods and supporting analyses, access the report appendixes at https://go.usa.gov/xGMxh.

This study sheds light on the importance of two factors in student success in Algebra I and college readiness: students' level of preparedness when they take

Algebra I and the grade level in which they complete Algebra I. Policies such as algebra-for-all have promoted access and opportunity for all students to take Algebra I before grade 9, but students must be ready for the course's content in order to succeed (Allensworth et al., 2009; Stein et al., 2011). Lower achieving students do not always benefit from taking Algebra I in middle school (Gamoran & Hannigan, 2000; Loveless, 2008), and Algebra I failure rates can be higher among students with lower grade point averages in prior years (Allensworth et al., 2009).

Knowing the rate at which students at the same grade 5 math proficiency level complete Algebra I in different grade levels and whether they have different high school outcomes can help education leaders review and refine the policies and practices that affect those outcomes. Determining whether economically disadvantaged students and English learner students have similar patterns of course placement and math outcomes can help in determining whether current practice promotes equity in access and success. Understanding patterns of student placement into Algebra I and their subsequent outcomes can inform critical examination and updates to policies about the grade level in which students take an advanced math course. Further, understanding Algebra I placement and student outcomes may facilitate a review and update of instructional practices that support student learning opportunities.

What this study examined

This study used administrative data from the Virginia Longitudinal Data System to describe the outcomes of students by their grade 5 math proficiency level and the grade level in which they completed Algebra I (grade 7, 8, or 9). The two outcomes studied are whether students passed the Algebra I state assessment and whether they earned a college preparatory diploma. The study also disaggregated results for economically disadvantaged students and English learner students. (See box 1 for definitions of key terms used in the report.)

The study addressed three research questions:

1. What percentages of the overall study population, economically disadvantaged students, and English learner students at each grade 5 math proficiency level completed Algebra I in grades 7, 8, and 9 in Virginia?

2. Among students who scored at the advanced proficient level in grade 5 math, what percentages of the overall study population, economically disadvantaged students, and English learner students passed the Algebra I state assessment, and what percentages earned a college preparatory diploma?

3. Among students who scored at the proficient level in grade 5 math, what percentages of the overall study population, economically disadvantaged students, and English learner students passed the Algebra I state assessment, and what percentages earned a college preparatory diploma?

Box 2 summarizes the study's data sources, study population, and methods, and appendix A provides additional detail.

Box 1. Key terms

Algebra I pass rate. The percentage of students who passed the Algebra I state assessment the first time they took it.

Algebra I state assessment. Virginia's Algebra I assessment, one of the state's Standards of Learning assessments (Virginia Department of Education, 2016), which students must pass to obtain a verified credit (see below) toward high school graduation requirements. A passing score is at least 400 (on a scale of 0–600). A student who fails the assessment can retake it within the same school year to earn the verified credit.

College preparatory diploma. An Advanced Studies diploma, which is one of two types of diplomas that Virginia public high school students can earn. The Advanced Studies diploma is considered a rigorous college preparatory high school diploma (Holian & Mokher, 2011; Jonas et al., 2012; Jonas et al., 2014) and requires four credits each of English, math, science, and history; three credits of a world language; and one credit of fine arts or career and technical education (Virginia Department of Education, n.d. a).

Economically disadvantaged student. A student who met any of the following criteria in grade 5: was eligible for the national school lunch program, received Temporary Assistance for Needy Families, was eligible for Medicaid, was identified as a migrant student, or experienced homelessness at any point during the school year (Virginia Department of Education, 2020).

English learner student. A student who met any of the following criteria in grade 5: received English learner services, was eligible to receive English learner services but did not, or was eligible for English learner services but completed the English learner program within the previous two years (Virginia Department of Education, 2020).

Grade 5 math proficiency level. A student's proficiency level on the grade 5 math state assessment. Virginia's state assessments, called the Standards of Learning assessments, have three proficiency levels. Scores of 0–399 are classified as below proficient, scores of 400–499 are classified as proficient, and scores of 500–600 are classified as advanced proficient. Scores of 400–600 (proficient and advanced proficient) are considered passing scores (Virginia Department of Education, n.d. c).

Grade level of Algebra I completion. The grade level (7, 8, or 9) in which a student completed Algebra I, proxied by the grade level in which the student took the Algebra I state assessment for the first time. State assessment data were used because they are of higher quality than course and transcript records (see appendix B). In Virginia, students who complete an Algebra I course must take the Algebra I state assessment at the end of the same school year in which they complete the course. Students who failed the assessment and retook Algebra I were included in the group for the grade level in which they first completed the course and took the assessment. For example, a student who completed an Algebra I course in grade 7, took and failed the Algebra I state assessment in grade 7, completed the Algebra I course again in grade 8, and passed the assessment in grade 8 was included in the group that completed Algebra I in grade 7.

Verified credit. A credit for which a student both completed the course requirements and passed the associated Standards of Learning state assessment (Virginia Department of Education, n.d. b).

Box 2. Data source, study population, and methods

Data source. The study used administrative data from the Virginia Longitudinal Data System, which contains information on all Virginia public school students in grades K–12, including their demographic characteristics and program participation, state assessment results, and courses taken.

Study population. The overall study population comprised one cohort of 61,200 Virginia public school students who were in grade 5 in the 2009/10 school year, completed Algebra I for the first time in grade 7, 8, or 9, and graduated from high school by August 2017. These students accounted for about 71 percent of the grade 5 students in Virginia public schools who were tested in the 2009/10 school year (see appendix A for details on the inclusion criteria for the study population). This cohort was selected because the students were subject to more rigorous high school graduation requirements and state math standards. Beginning with the cohort of students who started grade 9 in 2011/12, a college preparatory diploma required 26 total credits (including 9 verified credits; see box 1), with 4 credits of high school math (including 2 verified credits). In addition, in the 2011/12 school year math state assessments changed for grades 3–8, Algebra I, Algebra II, and geometry to align with state standards enacted in 2009 that included more rigorous content or content previously taught at a later grade level.

Methodology. The study team calculated descriptive statistics, including counts, percentages, and cross-tabulations, to describe the percentages of students who passed Algebra I and earned a college preparatory diploma, disaggregated by grade 5 math proficiency level and by when they completed Algebra I (in grade 7, 8, or 9). Results were calculated for the overall study population and for two subgroups: economically disadvantaged students and English learner students. The three groups are not mutually exclusive: the overall study population group includes economically disadvantaged students and English learner students, some economically disadvantaged students are also English learner students, and some English learner students are also economically disadvantaged students. By comparing students who were at the same math proficiency level in grade 5, the analysis accounted for a portion of pre-existing differences in students' preparedness for Algebra I content.

See appendix A for a complete list of the variables examined and a more detailed description of the data sources, study population, and methodology.

Findings

This section first presents the percentages of students in the overall study population and in each subgroup at each grade 5 math proficiency level who completed Algebra I in grades 7–9. It then presents the outcomes for students who scored at the advanced proficient level in grade 5 math and students who scored at the proficient level in grade 5 math. These outcomes include the percentage of students who passed the Algebra I state assessment and the percentage who earned a college preparatory diploma. These results are presented for the overall study population and for economically disadvantaged students and English learner students. The report discusses differences between groups that are larger than 2 percentage points.

A majority of students completed Algebra I in grade 8 or 9 regardless of their grade 5 math proficiency level

Among students in the overall study population at all grade 5 math proficiency levels, a majority completed Algebra I in grade 8 (42 percent) or grade 9 (42 percent; table 1). Among students in the overall study population who scored at the advanced proficient level in grade 5 math, 24 percent completed Algebra I in grade 7, 51 percent completed Algebra I in grade 8, and 25 percent completed Algebra I in grade 9.

Table 1. Across grade 5 math proficiency levels, a larger percentage of students completed Algebra I in grade 8 or 9 than in grade 7, 2009/10–2013/14

Grade 5 math proficiency level	Completed Algebra I in grade 7	Completed Algebra I in grade 8	Completed Algebra I in grade 9
Advanced proficient (*n* = 37,898)	24	51	25
Proficient (*n* = 18,391)	4	32	64
Below proficient (*n* = 4,911)	<1	13	86
All proficiency levels (*n* = 61,200)	16	42	42

Source: Authors' analysis using data from the Virginia Longitudinal Data System on students who took the grade 5 math state assessment in 2009/10 and who took the Algebra I state assessment for the first time in grade 7 in 2011/12, in grade 8 in 2012/13, or in grade 9 in 2013/14.

Larger percentages of economically disadvantaged students and of English learner students completed Algebra I in grade 9 compared with students in the overall study population, regardless of grade 5 proficiency level. About 56 percent of economically disadvantaged students and 64 percent of English learner students completed Algebra I in grade 9 (table 2). Among students who scored at the advanced proficient level in grade 5 math, 37 percent of economically disadvantaged students and 42 percent of English learner students completed Algebra I in grade 9. Both percentages are higher than the 25 percent of students in the overall study population who scored at the same grade 5 math proficiency level and completed Algebra I in grade 9 (see table 1).

Table 2. Across grade 5 math proficiency levels, the percentages of economically disadvantaged students and English learner students who completed Algebra I in grade 7 were smaller than the percentage of students in the overall study population who did, 2009/10–2013/14

Grade 5 math proficiency level	Completed Algebra I in grade 7	Completed Algebra I in grade 8	Completed Algebra I in grade 9
Economically disadvantaged students			
Advanced proficient (*n* = 10,872)	18	45	37
Proficient (*n* = 8,408)	3	27	69
Below proficient (*n* = 2,916)	0	12	87
All proficiency levels (*n* = 22,196)	10	34	56
English learner students			
Advanced proficient (*n* = 1,031)	17	42	42
Proficient (*n* = 1,242)	1	31	68
Below proficient (*n* = 835)	0	14	86
All proficiency levels (*n* = 3,108)	6	30	64

Source: Authors' analysis using data from the Virginia Longitudinal Data System on students who took the grade 5 math state assessment in 2009/10 and who took the Algebra I state assessment for the first time in grade 7 in 2011/12, in grade 8 in 2012/13, or in grade 9 in 2013/14.

Among students who scored at the advanced proficient level in grade 5 math, the percentage who earned a college preparatory diploma was higher for those who completed Algebra I in grade 7 than for those who completed it in grade 8 or 9

Among students in the overall study population who scored at the advanced proficient level in grade 5 math, Algebra I pass rates and the percentages who earned a college preparatory diploma varied based on when students completed Algebra I (figure 1). Those who completed Algebra I in grade 9 had lower pass rates (76 percent) than those who completed Algebra I in grade 7 (90 percent) or in grade 8 (89 percent). Likewise, 44 percent of those who completed Algebra I in grade 9 earned a college preparatory diploma compared with 80 percent of those who completed Algebra I in grade 7 and 75 percent of those who completed Algebra I in grade 8.

Among students who scored at the advanced proficient level in grade 5 math, lower percentages of economically disadvantaged students passed Algebra I and earned a college preparatory diploma compared with the overall study population, regardless of when they completed Algebra I. Among students who scored at the advanced proficient level in grade 5 math and completed Algebra I in grade 7, the Algebra I pass rate was 80 percent for economically disadvantaged students compared with 90 percent for the overall study population, and the percentage who earned a college preparatory diploma was 62 percent for economically disadvantaged students compared with 80 percent for the overall study population (see figure 1).

Among students who scored at the advanced proficient level in grade 5 math and completed Algebra I in grade 8, the Algebra I pass rate was 81 percent for economically disadvantaged students compared with 89 percent for the overall study population, and the percentage who earned a college preparatory diploma was 60 percent for economically disadvantaged students compared with 75 percent for the overall study population (see figure 1).

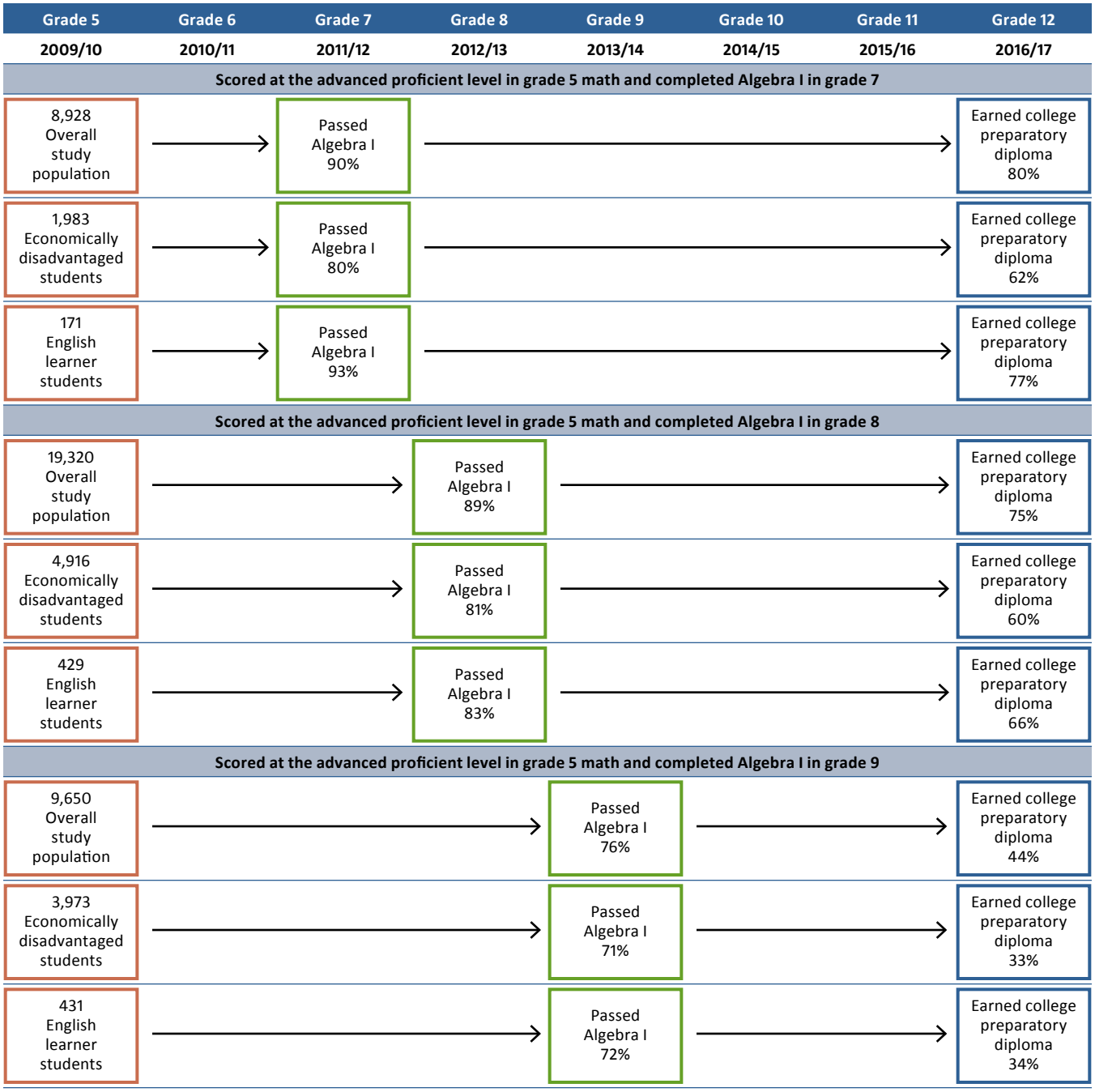
Among students who scored at the advanced proficient level in grade 5 math and completed Algebra I in grade 9, the Algebra I pass rate was 71 percent for economically disadvantaged students compared with 76 percent for the overall study population, and the percentage who earned a college preparatory diploma was 33 percent for economically disadvantaged students compared with 44 percent for the overall study population (see figure 1).

Among students who scored at the advanced proficient level in grade 5 math, a lower percentage of English learner students earned a college preparatory diploma compared with the overall study population, regardless of when they completed Algebra I. Among students who scored at the advanced proficient level in grade 5 math and completed Algebra I in grade 7, the percentage of English learner students who earned a college preparatory diploma was 77 percent compared with 80 percent for the overall study population (see figure 1).

Among students who scored at the advanced proficient level in grade 5 math and completed Algebra I in grade 8, the Algebra I pass rate was 83 percent for English learner students compared with 89 percent for the overall study population, and the percentage who earned a college preparatory diploma was 66 percent for English learner students compared with 75 percent for the overall study population (see figure 1).

Among students who scored at the advanced proficient level in grade 5 math and completed Algebra I in grade 9, the Algebra I pass rate was 72 percent for English learner students compared with 76 percent for the overall study population, and the percentage who earned a college preparatory diploma was 34 percent for English learner students compared with 44 percent for the overall study population (see figure 1).

Figure 1. Among students who scored at the advanced proficient level in grade 5 math, larger percentages of the overall study population earned a college preparatory diploma compared with economically disadvantaged students and English learner students, regardless of when they completed Algebra I, 2009/10–2016/17



Note: To pass Algebra I, students had to receive a score of 400 or higher (on a scale of 0–600) on the Algebra I state assessment. The denominator for the calculation of Algebra I pass rates and percentages of students who earned a college preparatory diploma is the number of students in the overall study population or in each subgroup who scored at the advanced proficient level on the grade 5 math state assessment and completed Algebra I in each grade level. For example, 90 percent of students in the overall study population who scored at the advanced proficient level in grade 5 math and completed Algebra I in grade 7 passed the Algebra I state assessment (calculated as 8,070 / 8,928), and 80 percent of students in the overall study population who scored at the advanced proficient level in grade 5 math and completed Algebra I in grade 7 earned a college preparatory diploma (calculated as 7,114 / 8,928).

Source: Authors' analysis using data from the Virginia Longitudinal Data System for students who took the grade 5 math state assessment in 2009/10; who took the Algebra I state assessment for the first time in grade 7 in 2011/12, in grade 8 in 2012/13, or in grade 9 in 2013/14; and who graduated in in 2016/17.

Among students who scored at the proficient level in grade 5 math, the Algebra I pass rate and the percentage who earned a college preparatory diploma was higher for those who completed Algebra I in grade 8 than for those who completed it in grade 7 or 9

Among students in the overall study population who scored at the proficient level in grade 5 math, Algebra I pass rates and the percentages who earned a college preparatory diploma varied based on when students completed Algebra I (figure 2). The pass rate for students who completed Algebra I in grade 9 (57 percent) was similar to the pass rate for those who completed Algebra I in grade 7 (59 percent) and lower than the pass rate for those who completed Algebra I in grade 8 (65 percent). Likewise, 26 percent of students who completed Algebra I in grade 9 earned a college preparatory diploma compared with 45 percent of those who completed Algebra I in grade 7 and 47 percent of those who completed Algebra I in grade 8.

Among students who scored at the proficient level in grade 5 math, lower percentages of economically disadvantaged students passed Algebra I and earned a college preparatory diploma compared with the overall study population, regardless of when they completed Algebra I. Among students who scored at the proficient level in grade 5 math and completed Algebra I in grade 7, the Algebra I pass rate was 48 percent for economically disadvantaged students compared with 59 percent of the overall study population, and the percentage who earned a college preparatory diploma was 29 percent compared with 45 percent for the overall study population (see figure 2).

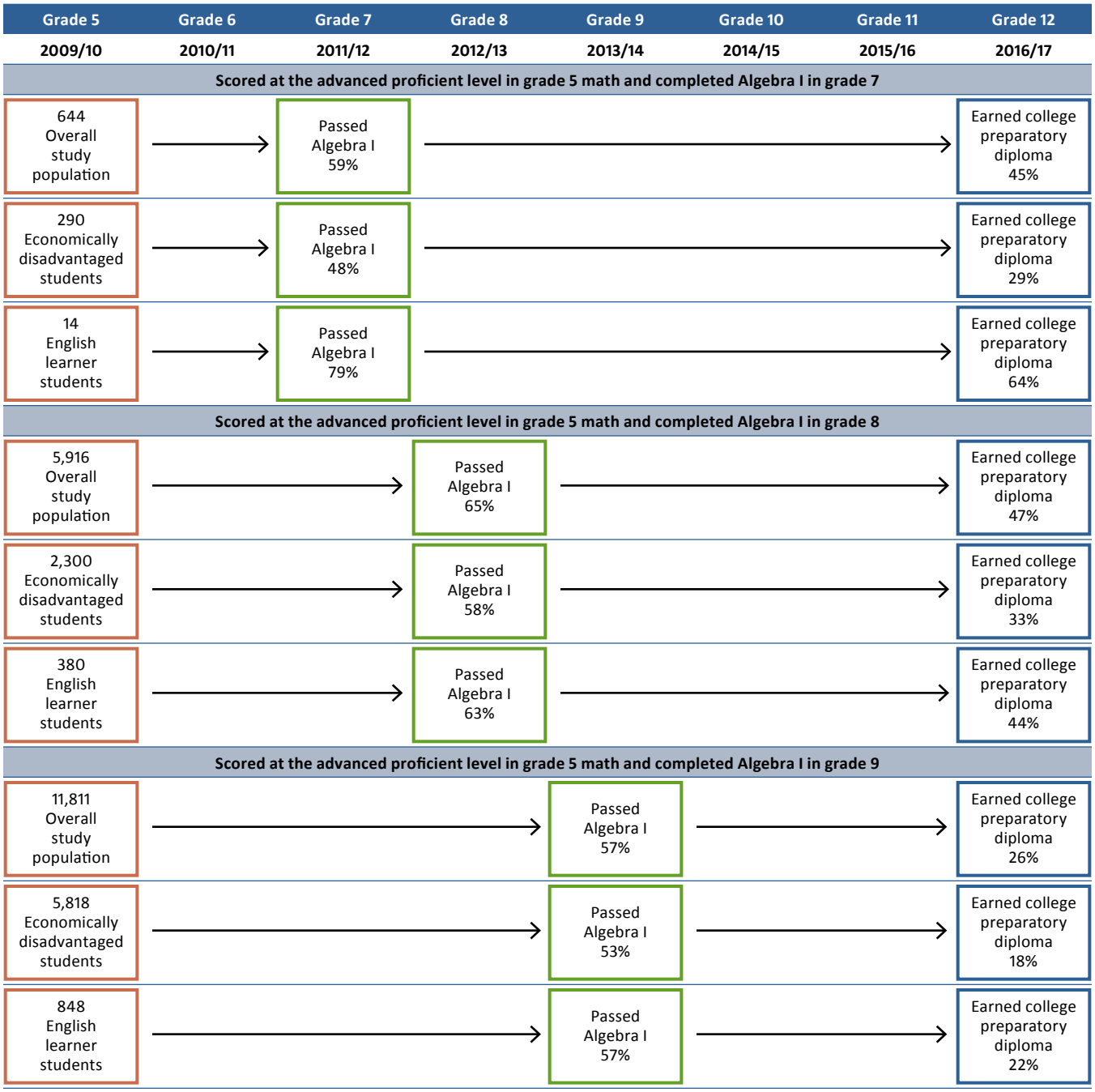
Among students who scored at the proficient level in grade 5 math and completed Algebra I in grade 8, the Algebra I pass rate was 58 percent for economically disadvantaged students compared with 65 percent for the overall study population, and the percentage who earned a college preparatory diploma was 33 percent for economically disadvantaged students compared with 47 percent for the overall study population (see figure 2).

Among students who scored at the proficient level in grade 5 math and completed Algebra I in grade 9, the Algebra I pass rate was 53 percent for economically disadvantaged students compared with 57 percent for the overall study population, and the percentage who earned a college preparatory diploma was 18 percent for economically disadvantaged students compared with 26 percent for the overall study population (see figure 2).

Among students who scored at the proficient level in grade 5 math, lower percentages of English learner students who completed Algebra I in grades 8 and 9 earned a college preparatory diploma compared with the overall study population. Among students who scored at the proficient level in grade 5 math and completed Algebra I in grade 8, the Algebra I pass rate was similar for English learner students (63 percent) and for the overall study population (65 percent), but the percentage who earned a college preparatory diploma was 44 percent for English learner students compared with 47 percent for the overall study population (see figure 2). Among students who scored at the proficient level in grade 5 math and completed Algebra I in grade 9, the Algebra I pass rate was the same for English learner students and the overall study population (57 percent), but the percentage who earned a college preparatory diploma was lower for English learner students (22 percent) than for the overall study population (26 percent).[1]

1. Because the number of English learner students who scored at the proficient level in grade 5 math and completed Algebra I in grade 7 is small (14 students), comparisons should be interpreted with caution and are not discussed further in the text.

Figure 2. Among students who scored at the proficient level in grade 5 math and completed Algebra I in grade 8 or 9, larger percentages of the overall study population earned a college preparatory diploma compared with economically disadvantaged students and English learner students 2009/10–2016/17



Note: To pass Algebra I, students had to receive a score of 400 or higher (on a scale of 0–600) on the Algebra I state assessment. The denominator for the calculation of Algebra I pass rates and percentages of students who earned a college preparatory diploma is the number of students in the overall study population or in each subgroup who scored at the proficient level on the grade 5 math state assessment and completed Algebra I in each grade level. For example, 59 percent of students in the overall study population who scored at the proficient level in grade 5 math and completed Algebra I in grade 7 passed the Algebra I state assessment (calculated as 389 / 664), and 45 percent of students in the overall study population who scored at the proficient level in grade 5 math and completed Algebra I in grade 7 earned a college preparatory diploma (calculated as 299 / 664).

Source: Authors' analysis using data from the Virginia Longitudinal Data System for students who took the grade 5 math state assessment in 2009/10; who took the Algebra I state assessment for the first time in grade 7 in 2011/12, in grade 8 in 2012/13, or in grade 9 in 2013/14; and who graduated in in 2016/17.

Limitations

The study has four main limitations. First, the analysis used descriptive statistics and cross-tabulations of population data. The findings do not show causality (for example, that taking Algebra I in grade 7 affected whether students earned a college preparatory diploma). Rather, they describe the characteristics and outcomes of students who completed Algebra I in grades 7–9.

Second, the study focused on a single graduating cohort of students. For categories of analysis with small sample sizes, such as the 14 English learner students who scored at the proficient level in grade 5 math and completed Algebra I in grade 7, the findings may be less applicable to other cohorts of students. In addition, in these small groups, small changes in the number of students with a particular outcome can result in large differences in the reported percentages, which may overstate the differences between groups.

Third, the reasons for placing students in Algebra I at a particular grade level (for example, grade 7 versus grade 9) were not available. Proficiency level on the grade 5 math state assessment is one factor in placement, but placement might also depend on students' scaled score within that level, on district-specific math placement exams (not available statewide), teacher recommendations, and parent requests. These factors may also affect students' outcomes, further underscoring that the findings do not indicate causality.

Fourth, the state assessment data used in the study are from a statewide administrative source that provides a summative measure of a student's math proficiency relative to state standards but does not contain detailed information on student understanding of math concepts and skills. Differences in the content that students have mastered may explain some of the variation in Algebra I and graduation outcomes among students who scored at the same proficiency level in grade 5 math.

Implications

The study findings suggest the need to better understand Algebra I placement policies and practices and whether they unintentionally contribute to differences in student access to Algebra I and subsequent outcomes. The variation in access to Algebra I in middle school and in outcomes among students who scored at the advanced proficient level in grade 5 math in the current study suggests the need to review school policies and practices in order to ensure that all students have access to and can benefit from learning opportunities. Any review should consider the importance of subjective placement criteria, such as teacher or parent recommendations, which introduce the potential for personal perspectives, opinions, and biases to influence placement decisions (Kibler et al., 2019; Vanlommel & Schildkamp, 2019).

The findings also suggest the need for policymakers and education leaders to investigate whether effective teaching practices are used and the subject matter is being taught in an equitable manner, given that economically disadvantaged students and English learner students who demonstrate strong math skills in grade 5 are trailing in Algebra I outcomes. Improving math instructional practices using evidence-based strategies has been shown to be effective for economically disadvantaged students (Lubienski, 2000) and English learner students (Moschkovich, 2002). These practices include using visual representations (Boaler, 2015; Woodward et al., 2012), exposing students to multiple problem-solving strategies (Woodward et al., 2012), and teaching students to intentionally choose from alternative algebraic strategies (Star et al., 2015). Ensuring access to cognitively rigorous and challenging math work (Bransford et al., 2000; Henningsen & Stein, 1997; Siegler, 2003; Silver & Stein, 1996) for all students might also benefit economically disadvantaged students and English learner students.

Finally, further research is needed on why rates of earning a college preparatory diploma were lower for economically disadvantaged students and English learner students than for the overall study population and lower for

students who completed Algebra I in grade 9 than for students who completed Algebra I in grade 7 or 8, regardless of students' prior math proficiency level. Students who take Algebra I in grade 9 can still earn four credits of high school math, which satisfies the criterion for a college preparatory diploma in Virginia. This study was not designed to determine whether the number and rigor of students' high school math courses led to lower rates of earning a college preparatory diploma. Future studies could examine the nuanced decisions that shape high school coursetaking and provide educators with information on how these choices affect students' graduation and other outcomes.

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