REL Appalachia Ask-A-REL Response

College and Career Readiness, Math
October 2017

Question:

What is the relationship between student mathematics achievement and the number of high school mathematics courses a student takes or that a state requires? How many mathematics courses do other states require?

Response:

Thank you for your request to our REL Reference Desk regarding evidence-based information about the relationship between student mathematics achievement and the number of high school mathematics courses a student takes or the state requires. Ask-A-REL is a collaborative reference desk service provided by the 10 Regional Educational Laboratories (RELs) that, by design, functions much in the same way as a technical reference library. Ask-A-REL provides references, referrals, and brief responses in the form of citations in response to questions about available education research.

Following an established REL Appalachia research protocol, we searched for research reports and descriptive study articles on high school mathematics course requirements. We focused on identifying resources that specifically addressed the effects of those requirements on mathematics achievement and college and career readiness. The sources included ERIC and other federally funded databases and organizations, research institutions, academic research databases, and general Internet search engines. For more details, please see the methods section at the end of this document.

The research team did not evaluate the quality of the resources provided in this response; we offer them only for your reference. Also, the search included the most commonly used research databases and search engines to produce the references presented here, but the references are not necessarily comprehensive, and other relevant references and resources may exist.

References

Achieve, Inc. (2015). *ELA, math, and science course requirements across states.* Retrieved from https://www.achieve.org/publications/ela-math-and-science-course-requirements-across-states

From the introduction: "This file contains a list of states' graduation requirements for each diploma (or course of study, endorsement or other classification the state offers) to students. This table details the number and specific names of the English language arts, mathematics, and science courses as defined by the source linked to in Column L…This online table will be live and dynamic; Achieve will make updates to it on an ongoing basis to reflect any graduation requirements policy changes that occur in states."

Achieve, Inc. (2013). *The value of the fourth year of mathematics*. Retrieved from https://www.achieve.org/publications/value-fourth-year-mathematics

From the introduction: "Too many students and educators view the senior year and graduation from high school as an end point, rather than one vital step along the education pipeline. Students who engage in a fourth year of math tap into and build upon their advanced analytic skills and are more likely to have better success in postsecondary course work, as they have maintained their momentum and continued to practice mathematics throughout their high school experience."

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college*. Washington, DC: U.S. Department of Education. Retrieved from http://eric.ed.gov/?id=ED490195

From the executive summary: "The Toolbox Revisited is a data essay that follows a nationally representative cohort of students from high school into postsecondary education, and asks what aspects of their formal schooling contribute to completing a bachelor's degree by their mid-20s. The universe of students is confined to those who attended a four-year college at any time, thus including students who started out in other types of institutions, particularly community colleges. The core question is not about basic 'access' to higher education. It is not about persistence to the second term or the second year following postsecondary entry. It is about completion of academic credentials—the culmination of opportunity, guidance, choice, effort, and commitment."

Bozick, R., & Ingels, S. J. (2008). *Mathematics coursetaking and achievement at the end of high school: Evidence from the Educational Longitudinal Study of 2002 (ELS:2002)* (NCES 2008-319). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://eric.ed.gov/?id=ED499546

From the executive summary: "Recent research shows that U.S. 15-year-olds are behind their international counterparts in problem solving and mathematics literacy, ranking 24th of 29 nations (Lemke et al. 2004). Therefore, a key concern among policymakers and educators is improving the quantitative and analytical skills of American youth, who face job prospects in an economy that increasingly values a strong foundation in mathematics and science. As a means to improve proficiency in this area, many states have increased their course requirements for graduation. This study, which uses data from the Education Longitudinal Study of 2002 (ELS:2002), improves upon past research by using information from high school transcripts to identify the exact course sequences students take and links them with achievement test scores that have been scaled to indicate different levels of

mathematics proficiency. This linkage provides a more detailed understanding of the curricular pathways students travel and the types of proficiencies they acquire along the way. Chapter 1 provides a brief background description of the pattern of mathematics coursetaking in the United States and lists the research questions. Chapter 2 describes the ELS:2002 data and the measures used in the analysis. Chapter 3 provides the results of the analysis. Chapter 4 concludes with a discussion of the findings and their limitations."

Byun, S., Irving, M. J., & Bell, B. A. (2015). Advanced math course taking: Effects on math achievement and college enrollment. *The Journal of Experimental Education, 83*(4), 439–468. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4620065/

From the abstract: "Using data from the Educational Longitudinal Study of 2002–2006 (ELS:02/06), this study investigated the effects of advanced math course taking on math achievement and college enrollment and how such effects varied by socioeconomic status (SES) and race/ethnicity. Results from propensity score matching and sensitivity analyses showed that advanced math course taking had positive effects on math achievement and college enrollment. Results also demonstrated that the effect of advanced math course taking on math achievement was greater for low SES students than for high SES students, but smaller for Black students than for White students. No interaction effects were found for college enrollment. Limitations, policy implications, and future research directions are discussed."

Daun-Barnett, N., & St. John, E. P. (2012). Constrained curriculum in high schools: The changing math standards and student achievement, high school graduation and college continuation. *Education Policy Analysis Archives, 20*(5), 1–25. Retrieved from http://eric.ed.gov/?id=EJ971424

From the abstract: "Mathematics education is a critical public policy issue in the U.S. and the pressures facing students and schools are compounded by increasing expectations for college attendance after high school. In this study, we examine whether policy efforts to constrain the high school curriculum in terms of course requirements and mandatory exit exams affects three educational outcomes—test scores on SAT math, high school completion, and college continuation rates. We employ two complementary analytic methods—fixed effects and difference in differences (DID)—on panel data for all 50 states from 1990 to 2008. Our findings suggest that within states both policies may prevent some students from completing high school, particularly in the near term, but both policies appear to increase the proportion of students who continue on to college if they do graduate from high school. The DID analyses provide more support for math course requirement policies than mandatory exit exams, but the effects are modest. Both the DID and fixed effects analyses confirm the importance of school funding in the improvement of high school graduation rates and test scores."

Long, M. C., Iatarola, P., & Conger, D. (2009). Explaining gaps in readiness for college-level math: The role of high school courses. *Education Finance and Policy, 4*(1), 1–33. Abstract

retrieved from http://eric.ed.gov/?id=EJ849850; full text available at http://www.mitpressjournals.org/doi/pdfplus/10.1162/edfp.2009.4.1.1

From the abstract: "Despite increased requirements for high school graduation, almost one-third of the nation's college freshmen are unprepared for college-level math. The need for remediation is particularly high among students who are low income, Hispanic, and black. Female students are also less likely than males to be ready for college-level math. This article estimates how much of these gaps are determined by the courses that students take while in high school. Using data on students in Florida public postsecondary institutions, we find that differences among college-going students in the highest math course taken explain 28–35 percent of black, Hispanic, and poverty gaps in readiness and over three-quarters of the Asian advantage. Courses fail to explain gender gaps in readiness. Low-income, black, and Asian students also receive lower returns to math courses, suggesting differential educational quality. This analysis is valuable to policy makers and educators seeking to reduce disparities in college readiness."

Parke, C. S. (2012). Examining relationships among assessment scores and math coursework in an urban school district. *Journal of Research in Education, 22*(1), 26–62. Retrieved from http://eric.ed.gov/?id=EJ1098356

From the abstract: "This study investigates relationships between assessment scores and other indicators of math performance. The impetus for the research came from a district's need to better understand high school math achievement. Longitudinal data for a cohort of students were obtained, including math scores from their state assessment, TerraNova, and New Standards Reference Examination; cumulative math GPA; number of math courses taken; and type of math courses taken. The paper illustrates how researchers can help districts utilize their extensive databases to proactively examine data beyond accountability requirements. A discussion focuses on how results helped target areas for improvement and identified further analysis within schools."

Shettle, C., Roey, S., Mordica, J., Perkins, R., Nord, C., Teodorovic, J.,…Brown, J. (2007). *The nation's report card: America's high school graduates* (NCES 2007-467). U.S. Department of Education, National Center for Education Statistics. Washington, DC: U.S. Government Printing Office. Retrieved from http://eric.ed.gov/?id=ED495682

From the abstract: "This report presents information about the types of courses 2005 high school graduates took during high school, how many credits they earned, and the grades they received. Information on the relationships between high school records and performance in mathematics and science on the National Assessment of Educational Progress (NAEP) is also included. Transcripts were collected from a nationally representative sample of 26,000 high school graduates. The 2005 results are compared to the results of earlier transcript studies, and differences among graduates by race/ethnicity, gender, and parent education are examined. Study findings include: 2005 graduates earned approximately three more credits (about 360 additional hours of instruction during their high school careers) than their 1990 counterparts. In 2005, the overall grade point average (GPA) was approximately a third of a letter grade higher than in 1990. Graduates with

stronger academic records obtain higher NAEP scores. For example, graduates whose highest mathematics course was geometry or below had average NAEP mathematics scores below the Basic achievement level, while graduates who took calculus had average NAEP scores at the Proficient level. Female graduates' GPAs overall and in mathematics and science were higher than the GPAs of male graduates during each year the HSTS was conducted. Among those who took higher level mathematics and science courses, male graduates had higher NAEP scores than female graduates. Increased percentages of White, Black, Hispanic, and Asian/Pacific Islander graduates completed at least a midlevel curriculum in 2005 compared with 1990. The GPAs of all four racial/ethnic groups also increased during this time. In 2005, both Black and Hispanic graduates were less likely than White graduates to have completed calculus or advanced science courses and to have higher GPAs."

Zelkowski, J. (2010). Secondary mathematics: Four credits, block schedules, continuous enrollment? What maximizes college readiness. *Mathematics Educator, 20*(1), 8–21. Retrieved from http://eric.ed.gov/?id=EJ892414

From the abstract: "This paper posits the position that if higher education and secondary schools wish to increase students' college readiness, specifically in mathematics and critical thinking skills, continuous enrollment in secondary mathematics is one avenue worth exploring as opposed to increasing mathematics graduation requirements only in terms of Carnegie credits. NAEP-HSTS 2005 and NELS:88 data indicate, respectively, non-continuous enrollment in secondary mathematics results in lower mathematics achievement and decreases the odds of completing a bachelor's degree. Nationally, schools following 4x4 block schedules (90-minute classes that meet daily for only one semester) were found to have mathematics achievement scores two thirds of one grade-level lower than schools following a 50-minute year-long mathematics courses. Typical college-bound students who do not take mathematics all four years of high school likely diminish their odds of bachelor degree completion by about 20%."

Additional Organizations to Consult

College & Career Readiness & Success Center: http://www.ccrscenter.org/

From the website: "The College and Career Readiness and Success Center (CCRS Center) is dedicated to ensuring all students graduate high school ready for college and career success. The mission of the CCRS Center is to serve Regional Comprehensive Centers in building the capacity of states to effectively implement initiatives for college and career readiness and success. Through technical assistance delivery and supporting resources, the CCRS Center provides customized support that facilitates the continuous design, implementation, and improvement of college and career readiness priorities."

Methods

Keywords and Search Strings

The following keywords and search strings were used to search the reference databases and other sources:

- (High school math course credit require*) AND achievement
- (Coursetaking OR "course taking" OR course-taking) AND math*
- High school math outcomes

Databases and Resources

We searched ERIC, a free online library of more than 1.6 million citations of education research sponsored by the Institute of Education Sciences (IES), for relevant resources. Additionally, we searched the academic database ProQuest, Google Scholar, and the commercial search engine Google.

Reference Search and Selection Criteria

In reviewing resources, Reference Desk researchers consider—among other things—these four factors:

- Date of the publication: Searches cover the most current information (i.e., within the last ten years), except in the case of nationally known seminal resources.
- Search priorities of reference sources: Search priorities include IES, nationally funded, and certain other vetted sources known for strict attention to research protocols. Applicable resources must be publicly available online and in English.
- Methodology: The following methodological priorities/considerations guide the review and selection of the references: (a) study types—randomized controlled trials, quasi experiments, surveys, descriptive data analyses, literature reviews, policy briefs, etc., generally in this order; (b) target population, samples (representativeness of the target population, sample size, volunteered or randomly selected), study duration, etc.; (c) limitations, generalizability of the findings and conclusions, etc.
- Existing knowledge base: Vetted resources (e.g., peer-reviewed research journals) are the primary focus, but the research base is occasionally slim or nonexistent. In those cases, the best resources available may include, for example, reports, white papers, guides, reviews in non-peer-reviewed journals, newspaper articles, interviews with content specialists, and organization websites.

Resources included in this document were last accessed on September 14, 2017. URLs, descriptions, and content included here were current at that time.

This memorandum is one in a series of quick-turnaround responses to specific questions posed by education stakeholders in the Appalachia region (Kentucky, Tennessee, Virginia, and West Virginia), which is served by the Regional Educational Laboratory Appalachia (REL AP) at SRI International. This Ask-A-REL response was developed by REL AP under Contract ED-IES-17-C-0004 from the U.S. Department of Education, Institute of Education Sciences, administered by SRI International. The