RESEARCH BRIEF: MATH 1050
UTAH'S COLLEGE ALGEBRA

UTAH EDUCATION POLICY CENTER
THE UNIVERSITY OF UTAH

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College Algebra has caught the attention of researchers and policy makers. It is a required course for many undergraduate degrees,[1] yet many students find themselves unprepared to complete it successfully:[2]

- The ACT reported that a surprising 54% of the 2012 high school graduates were not prepared for college algebra.[3]
- University math classes are among the most likely classes to be withdrawn from and repeated.[4]
- In Utah, less than half of high school students meet the ACT's benchmark standard for college algebra.[5]

Efforts to ensure that students are ready to succeed in college algebra have focused primarily on improving the preparation of students in secondary school.[6] This has resulted in policies that dictate the number or type of math classes that high school students are required to take.[7] For example, several states require all high school students to take a minimum of Algebra, Geometry, and Algebra II.[8] In Utah, as of 2013, high school students are required to complete the Utah Core State Standards of Mathematics I, II, and III or higher.[9] Another approach to helping students earn credit for college algebra is to offer the class for college credit during high school.[10] Known as *concurrent enrollment*, this practice has gained increasing popularity in some states.

In an effort to better understand student preparedness for college algebra (Math 1050) in Utah, this research brief summarizes factors that predicted the success of Utah students enrolled in Math 1050 in the fall semester of 2011. This sample was the most recent cohort of students for which data were available through the Utah Data Alliance at the time we conducted the analysis.

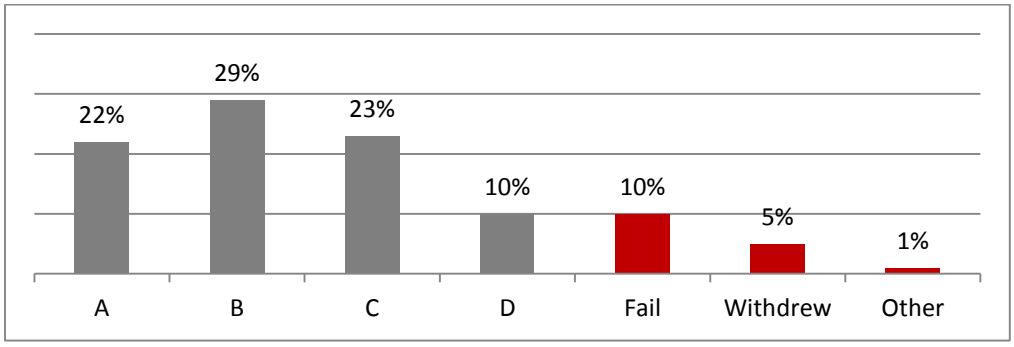
UTAH COLLEGE ALGEBRA OUTCOMES

The Utah Education Policy Center (UEPC) examined a cohort of 3,033 students enrolled in Math 1050 in Utah in the fall semester of 2011 who had math records in Utah secondary schools beginning with Pre-Algebra. Figure 1 presents the distribution of Math 1050 grades earned by this cohort of students. We considered students who earned an A through a D- as earning credit for the course and students who failed, withdrew, or otherwise did not receive credit for the course as not earning credit. Although some degree programs may require students to earn a C or better, D- is a generally accepted minimum for earning credit in college courses.

Of the 3,033 students in this cohort:

- 84% earned a D- or better,
- 10% failed, and
- 6% withdrew or did not earn credit.

Figure 1. Fall 2011 Math 1050 Grade Distribution



This study was conducted using data available from the Utah Data Alliance of which the UEPC is a founding member.

PREDICTORS OF EARNED CREDIT FOR MATH 1050

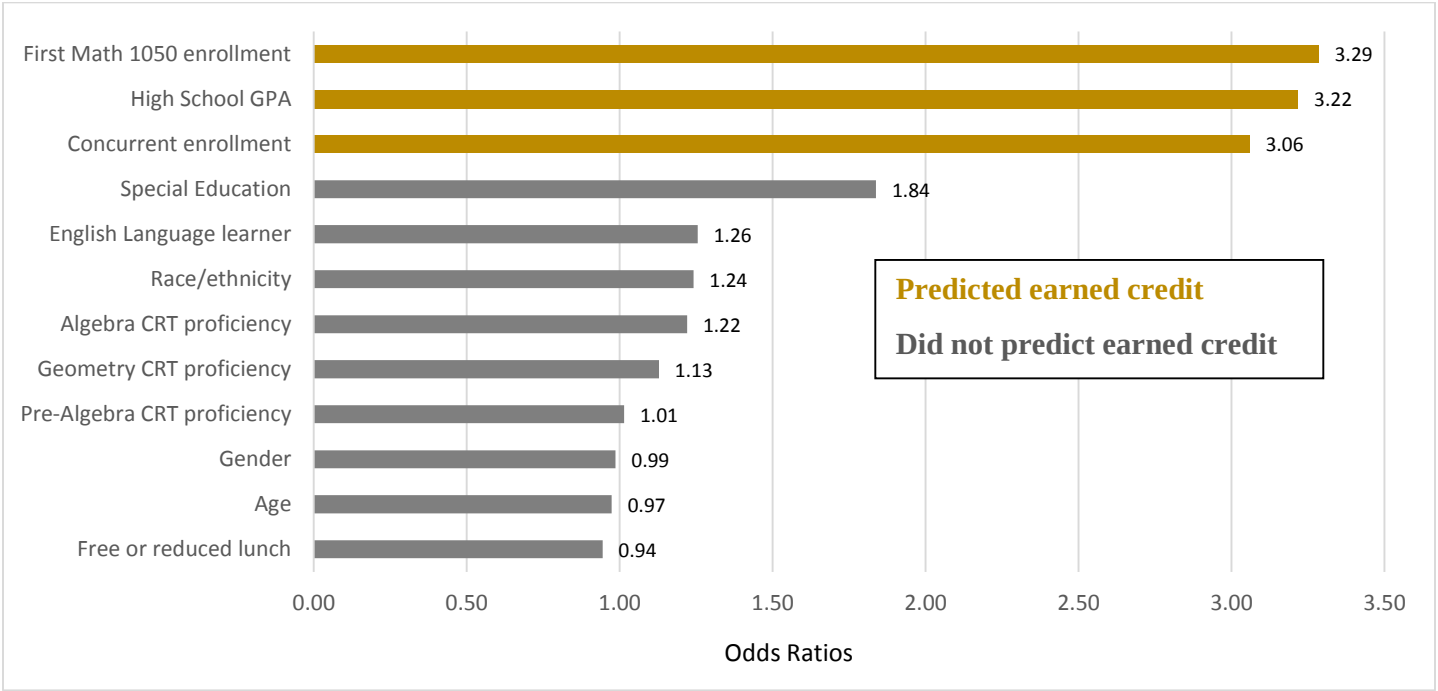
Since the primary goal of the analyses was to determine the factors that predicted earned credit in Math 1050, we examined factors that previous research suggested would be associated with success in college algebra.[11] We first examined 13 factors by isolating each one as an individual predictor of earned credit. Ten of those factors predicted earned credit in Math 1050 when considered individually (see Table 1).

Table 1. Individual Factors That Predicted Success in Math 1050

Factors that predicted earned credit when considered as individual predictors:		Factors that did not predict earned credit:
• ACT (met math benchmark or not) • Age (continuous) • Cumulative H.S. GPA (continuous) • Algebra CRT (proficient or not) • Geometry CRT (proficient or not)	• Pre-Algebra CRT (proficient or not) • Language (English learner or not) • First time Math 1050 enrollment (first time enrollee or not) • Math 1050 enrollment (concurrent or not) • Race/ethnicity (white or not)	• Gender • Economic disadvantage (free/reduced lunch or not) • Special education[12]

To learn more about the role of the factors that predicted earned credit, and to better understand the shared relationships among all of the factors, we ran a final statistical prediction that included all of the factors together.[13] This allowed us to consider the shared influence of 12 factors.[14] When all 12 factors were considered together, first time enrollment, high school GPA, and concurrent enrollment were the only significant predictors of earned credit in Math 1050. Six of the factors (age, English language learner status, Pre-Algebra CRT proficiency, Algebra CRT proficiency, Geometry CRT proficiency, and race/ethnicity) no longer predicted earned credit. This suggests that while important, those six factors provided a poor explanation of earned credit when considered along with other factors. Figure 2 shows the likelihood of earned credit based on each predictor. When all factors were considered simultaneously, students who took the course for the first time, had high school GPAs of 3.5 or higher, or were concurrently enrolled were over three times more likely to earn credit for Math 1050 than students who were retaking the course, had GPAs below 3.5, or took the course in college.

Figure 2. Likelihood of Earning Credit for Math 1050 When All Factors Are Considered Together



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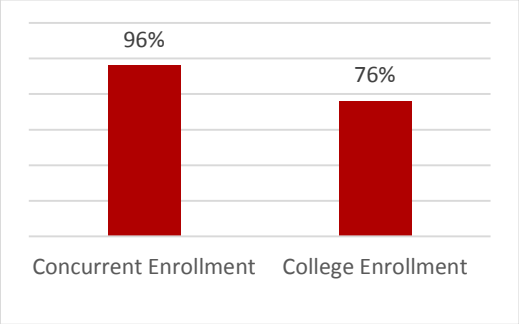
First Time Enrollment in Math 1050

While 90% of students enrolled in Math 1050 for the first time earned credit, only 60% of students retaking the class earned credit. This finding brings up a number of questions about differences between these groups of students. Further examination is warranted to identify differences between the students who did and did not succeed in Math 1050 on their first attempt. Future studies might focus on groups of students who retake Math 1050 to determine their mathematics coursework prior to their first attempt and after they failed to earn credit for Math 1050.

High School Students Concurrently Enrolled vs. College Students

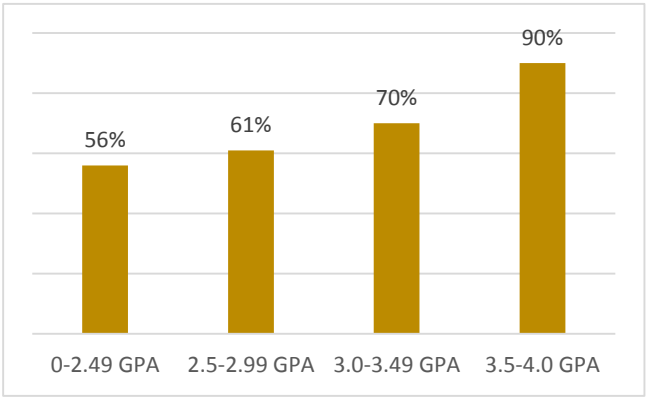
Figure 3. Earned Credit by Enrollment Status



High school students can enroll in Math 1050 through concurrent enrollment programs. In our sample, there were 1,243 Utah high school students concurrently enrolled in Math 1050 and 96% of those students earned credit for Math 1050, compared to 76% of students who took Math 1050 in college. While this result seems to indicate a substantial benefit to taking Math 1050 in high school, further research is needed to understand this finding. In particular, we do not know the reasons for the greater success of high school students. For example, reasons might include differences in rigor of the math courses taken in high school versus those taken in college, the structure offered in high school (e.g., mandatory daily attendance), and/or differences in the math preparation of these two groups of students. Future research might also explore whether student outcomes after Math 1050 are different depending on whether the class was taken in college or high school.

Cumulative High School GPA

Figure 4. Percent of Students Who Earned Credit by High School GPA Segment



A cumulative high school GPA of 4.0 is the highest that a student can earn. The average high school GPA was 3.71 for students who earned credit for Math 1050 and 3.35 for students who did not earn credit. Figure 4 shows the percentages of students who earned credit in four segments of cumulative high school GPA scores. The percentage of students who earned credit in Math 1050 increased as their cumulative high school GPA increased. While this finding may not be surprising by itself, it is worth noting that high school GPA predicted success in Math 1050 over and above high school mathematics CRT scores. This is particularly striking given that cumulative high school GPA includes a full range of courses, not just mathematics. Given the predictive ability of GPA, additional support for students with low GPAs early in their secondary education may be warranted.

Conclusion

This study identified three factors that predicted earned credit in Math 1050 over and above all other predictors. These factors were first time enrollment in Math 1050, taking Math 1050 as a concurrently enrolled student, and cumulative high school GPA. Given the importance of Math 1050 as a gateway to particular majors in post-secondary education, future studies might consider how these three areas could become central in policies and practices related to mathematics preparation. To determine whether such policies and practices are viable, further investigation is necessary to determine whether these findings are replicated in a similar sample expanded to include additional semesters of Math 1050 students.

This study was conducted using data available from the Utah Data Alliance of which the UEPC is a founding member.

1 In Utah, all science, technology, engineering, and math (STEM) fields, all Bachelor of Science, and many Bachelor of Arts degrees require college algebra.

2 Long, M. C., Latarola, 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.

3 ACT. (February 2013). Readiness matters: The impact of college readiness on college persistence and degree completion (Policy Brief). Iowa City, IA: Author.

4 Herzog, S. (2005). Measuring determinants of student return vs. dropout/stopout vs. transfer: A first-to-second year analysis of new freshmen. Research in Higher Education, 46(8), 883-928.

5 ACT. (2012). The reality of college readiness: Utah (Annual Report). Iowa City, IA: Author.

6 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), 1-26.

Education Resource Institute (2007). Academic rigor: At the heart of college access and success. A college readiness issue brief of the Pathways to College Network. Retrieved from http://inpathways.net/crib%20academic%20rigor%20at%20the%20heart.pdf

7 Gaertner, M., N., Kim, J., DesJardins, S. L., & McClarty, K. L. (2014). Preparing students for college and careers: The causal role of algebra II. *Research in Higher Education, 55*(2), 143-165. DOI 10.1007/s11162-013-9322-7.

Golfin, P., Jordon, W., Hull, D., & Ruffin, M. (2005, September). Strengthening mathematics skills at the postsecondary level: Literature review and analysis. Report prepared by the CNA Corporation for U.S. Department of Education, Office of Vocational and Adult Education, Division of Adult Education and Literacy. Washington, DC. Retrieved from http://www.cna.org/sites/default/files/IPR11659.pdf

8 Achieve (2013). State college- and career-ready high school graduation requirements. Retrieved March 4, 2014 from http://www.achieve.org/publications/state-college-and-career-ready-high-school-graduation-requirements-comparison-table.

Harvill, E. L. (2011). High school math curriculum, student's course selection and education outcomes. (Unpublished doctoral dissertation). University of Pennsylvania. Philadelphia, PA.

9 Retrieved from http://www.schools.utah.gov/CURR/gradinfo/Home/High-School-Requirements-by-Year.aspx

10 Adelman, C. (2006). The toolbox revisited: Paths to degree completion from high school through college. U.S. Department of Education, Institute of Educational Sciences. Retrieved from http://www2.ed.gov/rschstat/research/pubs/toolboxrevisit/toolbox.pdf

11 Factors were compiled from research cited above.

12 Special education is an interesting variable in these analyses. Although it is one of three variables that does not predict Math 1050 completion when considered alone, when considered with all other variables simultaneously, it has greater predictive value than other variables that were predictive when considered alone (e.g., English language learner, race/ethnicity, and CRT proficiencies). Additionally, in the full model, prior involvement in special education increases the likelihood of passing Math 1050, which is a counterintuitive result. These results can be explained by statistical suppression, in which the presence of other variables increases the relationship of a predictor variable with the outcome variable. Thus, when all other variables are held constant and only like students are compared (students of the same gender, socioeconomic status, age, GPA, CRT proficiencies, etc.), students who received special education services are more likely (but not significantly more likely) to pass Math 1050 than students who did not receive special education services.

13 Because we used multiple factors to predict a binary outcome, we conducted a multiple logistic regression. Results presented are the increased odds of earning credit in Math 1050 given a one unit increase in the predictor variable with all other variables held constant.

14 ACT scores could not be included in this analysis because 30% of the students took the ACT after they had taken Math 1050. We explored the role of ACT scores in similar predictive analyses and it was not a significant predictor of earned credit in Math 1050.

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