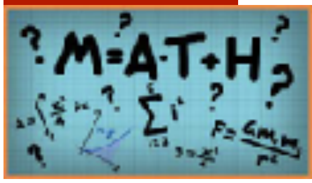
Summer 2018

RESEARCH BRIEF

The Persistence of the U.S. Mathematics Opportunity Gap and Outcomes for Future Citizens



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Introduction

The an international report highlighting inequity in schools, Grudnoff and colleagues describe a "persistent problem of inequitable educational outcomes and opportunities between advantaged and disadvantaged students" (Grudnoff, Haigh, Hill, Cochran-Smith, Ell, and Ludlow, 2017, p. 305). Additional scholars identify race and ethnicity as characteristic of what has been termed the *opportunity gap* in United States', and more specifically, urban schools (Landsman & Lewis, 2011; Triplett & Ford, 2019). The need to attend to the facets of equitable education are especially pertinent in US mathematics classrooms as data suggests that disproportionate mathematical progress and opportunity continues according to race/ethnicity and may result in inequitable outcomes for future citizens (NCES, 2019; The Nation's Report Card, 2019; US Department of Education Office for Civil Rights, 2018).

According to The Nation's Report Card, "students performing at or above the NAEP *Proficient* level on NAEP assessments demonstrate solid academic performance and competency over challenging subject matter" (The Nation's Report Card, 2019, para. 3). Performance on 4th and 8th grade NAEP assessments suggest that the majority of Asian and Pacific Islander students are considered proficient in mathematics, students who are classified as white or two or more races are approaching a dichotomy along the lines of proficiency, and the majority of Hispanic, Native Hawaiian/Other Pacific Islander, American Indian/Alaska Native, and black students are not considered proficient in mathematics (see Appendix, Table 1). Alarmingly, a 13 to 19 percent gap exists between each of these three proficiency groups. Though enrollment data is not available for the 2019 school year, it could be expected that each of these subgroups would enroll in high school mathematics courses proportional to either their student population or according to the proficiency categories outlined above (*majority proficient, approaching dichotomy, majority not proficient*). If enrollment trends persist, 2015-2016 data suggests that neither conjecture is the case.

It is widely argued that Algebra 1 and Calculus are considered gatekeeper courses for both STEM and university success (US Department of Education Office for Civil Rights, 2018). While Algebra 1 is a prerequisite for all upper-level mathematics courses, Calculus enrollment is recognized as a predictor of college success (Bressoud, 2016). Additionally, Champion and Mesa (2016) found that students who enroll in Calculus before 9th grade are significantly more likely to complete Calculus in high school. As Table 2 suggests, both white and Asian students are overrepresented in Algebra 1 as 8th grade students, while all other racial subgroups are enrolled at proportional or lower rates. Table 2 also shows that white and Asian students are underrepresented in Algebra 1 in 9th-12th grade, while Hispanic, Native Hawaiian/Other Pacific Islander, American Indian/Alaska Native, and black students are enrolled at higher rates. The over-represenation of Asian and white students coupled with a growing reduction in Hispanic and black student enrollment in advanced math courses, continues to support the notion of an opportunity gap for students of color in US mathematics education.

The major differences in proficiency and enrollment by race and ethnicity are especially concerning given the benefits of STEM success and the requirements for obtaining a STEM occupation. According to the US Bureau of Labor Statistics, 93 percent of STEM related careers in 2015 had wages above the national average and STEM graduates have been found to earn some of the highest beginning salaries (Fayer, Lacey & Watson, 2017). STEM employees report high levels of job satisfaction resulting from their high salaries, good work environments, minimal stress and high projected job growth (CareerCast, 2019). In *The 2019 Jobs Rated Report* from CareerCast, STEM jobs made up 8 out of the top ten reported jobs, including data scientist, statistician, mathematician, and actuary (CareerCast, 2019).

STEM is one of the fastest growing industries in the United States (Fayer, Lacey & Watson, 2017). A 2017 report from the US Bureau of Labor Statistics maintains an average projected growth of 6.5 percent for all occupations. In contrast, STEM occupations in the Mathematical Sciences were projected to grow by 28.2 percent from 2014-2024, resulting in 42,900 new jobs. In addition to high growth in other STEM occupations, they projected 500,000 new computer jobs, and 65,000 new engineering occupations to arise in the same time frame (Fayer, Lacey & Watson, 2017).

Table 1. Percentage at or above NAEP Proficient

	[illegible]		[illegible]		
Race/Ethnicity	4th grade	8th grade	4th grade	8th grade	
All	[illegible]	[illegible]	[illegible]	[illegible]	
Asian	[illegible]	[illegible]	[illegible]	[illegible]	(a) Majority proficient
Asian/Pacific Islander	[illegible]	[illegible]	[illegible]	[illegible]	
White	[illegible]	[illegible]	[illegible]	[illegible]	(b) Approaching dichotomy
Two or more races	[illegible]	[illegible]	[illegible]	[illegible]	
Hispanic	[illegible]	[illegible]	[illegible]	[illegible]	(c) Majority not proficient
Native Hawaiian/Other Pacific Islander	[illegible]	[illegible]	[illegible]	[illegible]	
American Indian/Alaska Native	[illegible]	[illegible]	[illegible]	[illegible]	
Black	[illegible]	[illegible]	[illegible]	[illegible]	

Source: The Nation's Report Card, 2019 NAEP Data

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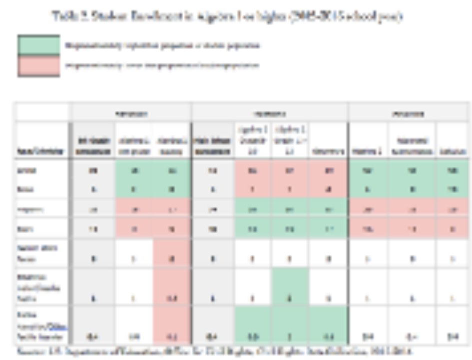
The educational requirements for 99 percent of STEM occupations consist of at least some postsecondary education while 73 percent of STEM employers require at least a bachelor's degree (Fayer, Lacey & Watson, 2017). Almost universally, admission to college in a STEM related field requires four years of high school mathematics including Pre-Calculus and Calculus, preferably taken in an advanced setting (Grove, 2019). The course enrollment data cited above suggests that future STEM employment opportunities will be disproportionately filled according to race/ethnicity, and will be filled at higher rates by those who are able to enroll in Algebra 1 in 8th grade and complete Advanced Calculus in high school, namely white and Asian students. This disproportionality is also evident in the percentage of degrees awarded in STEM related fields (NCES, 2019). In the 2015-2016 school year, white, Asian, and students of two or more races received STEM degrees at a higher or proportional rate to their percentage of the student population, while black, Hispanic, American Indian/Alaska native, and Pacific Islander students were awarded STEM degrees at lower rates than their proportion of the student population (NCES, 2019).

In this increasingly quantitative and digital world, a citizens inability to reason with data not only restricts their access to STEM careers and their associated benefits, but also infringes upon their ability to advocate for themselves in a data driven democracy and the global economy (Cobb, 1999; Gravemeijer et al, 2017; NCTM, n.d.; Steen, 2001). Data-based arguments have become the language of politics, policy, and the economy and illiteracy in this regard translates to a lack of advocacy and representation for personal interests (Cobb, 1999; Ernest, 2018; Steen, 2001). Given the rapid growth of the STEM industry and its irrefutable influence on daily life, the underrepresentation of certain racial/ethnic groups in both STEM careers and as mathematically literate advocates for their respective cultures, ensures that societal priorities are destined to reflect the values of the quantitatively literate majority (NCES, 2019).

K12 schools maintain a critical role in fostering the mathematical engagement and quantitative literacy required for participation in democracy and STEM success (Finkel, 2017). Unfortunately, the nature of both the science and mathematics curriculum in US schools are considered tedious and irrelevant to the vast majority of students. To ensure that all students have access to satisfactory employment, job security, and cultural advocacy, it is imperative that educators become aware of their role in preparing all of today's youth for tomorrow's industry. This requires that schools begin to prioritize every student's STEM success, that individual teachers develop a sense of agency and research-based practice, and that administrators support teachers in performing action research to improve student learning with practical and relevant solutions (Mertler, 2014). Mathematical literacy is now absolutely necessary for pursuing quality of life, advocating for personal and cultural interests, and acquiring equitable outcomes across human difference. As such, it must become our individual responsibility as parents, teachers, researchers, administrators, and politicians to seek equitable STEM



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