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Does attending a STEM high school improve student performance? Evidence from New York City☆

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ABSTRACT

We investigate the role of specialized science, technology, engineering, and mathematics (STEM) high schools in New York City (NYC) in promoting performance in science and mathematics and in closing the gender and race gaps in STEM subjects. Using administrative data covering several recent cohorts of public school students and a rich variety of high schools including over 30 STEMs, we estimate the effect of attending a STEM high school on a variety of student outcomes, including test taking and performance on specialized science and mathematics examinations. While comparisons of means indicate an advantage to attending a STEM school, more thorough analysis conditioning on a rich set of covariates, including previous grade test performance, reduces or eliminates this advantage. Females and males in STEMs do better than their counterparts in Non-STEMs, but the gender gap is also larger in these schools. We also find that the black-white and Hispanic-white gaps are smaller in STEM relative to Non-STEM schools across almost all outcomes, but the Asian-white gap, in contrast, is larger in STEMs relative to Non-STEMs.

1. Introduction

Driven by concerns that the flow of U.S. students into science, technology, engineering, and mathematics (STEM) fields is inadequate to maintain a competitive advantage in technical fields, policymakers increasingly support the creation of high schools that focus on STEM education (hereafter STEM high schools or STEMS).[1] In addition to encouraging more students to enter science and technology fields, STEM high schools are purported to help mitigate the outflow of females and minorities from STEM education and careers. This push for STEM high schools, however, has not been accompanied by rigorous research supporting their effectiveness. Quite possibly, students in STEM schools could have performed as well if they had attended a Non-STEM school. For females and minorities, while STEM schools might provide an opportunity to "catch-up" with the performance of males and whites respectively, they might also foster environments in which females, blacks and Hispanics feel out of place. As our review of the previous literature makes clear, STEM schools have been described as providing "chilly environments" to females and minorities. Therefore, whether STEM schools can improve the size as well as the composition of the STEM education pipeline is an empirical question, which we aim to help answer in this paper.

Policymakers' focus on STEM education is well placed. Innovation in science and technology is becoming critical for economic growth in a fast-paced globalized world

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[1] Widespread support for more STEM-focused high schools has been reflected in different government reports, particularly "Prepare and Inspire: K-12 Education in STEM for America's Future" (PCAST, 2010), "Building a STEM Agenda" (National Governors Association, 2007), and "Rising Above the Gathering Storm" (National Research Council, 2007). President Obama, in his 2013 State of the Union address, signaled his strong support for STEM-focused high schools as a way to motivate and prepare students to pursue STEM.

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where it is estimated that STEM jobs will account for most of job creation in the near future (U.S. Commerce Department, 2011; The National Academies, 2010). In the meantime, the U.S. Department of Labor estimates only 5% of U.S. workers are employed in fields related to STEM, and international tests show that U.S. students rank well below many foreign competitors in math and science (Education Next, 2011). Compounding these problems, minorities and women are under-represented in STEM education, which has resulted in an additional loss of human capital from individuals who could potentially make important contributions to science or engineering if their career choices were different (Blickenstaff, 2005; Rask, 2010).[2]

Increasing the number of STEM high schools is a particularly promising policy intervention to address the challenges in STEM education and careers. Evidence clearly indicates that high schools play a key role in shaping students' attitudes and preparation for science and technology fields. The quality of STEM education in American high schools, however, is low, as evidenced by national and international exam scores (Richardson et al., 2003; The National Academies, 2010).[3] Moreover, performance of women and minorities in STEM education leaves room for improvement for both groups (Ceci & Williams, 2011; Ceci, Williams, & Barnett, 2009). Females are widely outnumbered among the highest achievers and a large gender gap persists in the more advanced math and science tests – females trail males on the mathematics section of the SAT and ACT examinations, are less likely to take advanced placement (AP) exams in STEM-related subjects, and, among takers, earn lower scores (Hill & St. Rose, 2010).[4] Similarly, minorities are more likely to drop out of STEM courses and disciplines and the percentage of all STEM bachelor's degrees awarded to African Americans or Hispanics continues to be relatively low (NSF Science and Engineering Indicators, 2009).

Still, little is known about whether STEM schools are a way to improve STEM education, a question we address in this paper. For this, we use a rich dataset from New York City (NYC) public high school students, which allows us to control for a wide range of student characteristics that are likely to affect students' academic achievement and their STEM attendance. In addition to the question of whether STEMs are effective in general, we also ask whether their effects differ by gender and race/ethnicity (hereafter race). NYC is a particularly useful and relevant setting to study these issues because it is a large, racially diverse urban school system, which makes results applicable to other urban settings that face the challenge of educating diverse students. Most important, NYC houses a large number of high schools, within which there is variation in mission and focus, including comprehensive schools, arts schools and, critical for the purposes of our study, STEM schools. Finally, the availability of a longitudinal student-level database, with information on statewide math and science tests administered in both middle and high school, allows us to investigate the relationship between student performance and attendance at a STEM school conditioning on a rich set of covariates including past performance in a value-added framework.

Briefly, we find that comparisons of raw unconditioned mean outcomes indicate that students attending STEM schools take math and science tests at higher rates and earn higher exam scores than students attending other high schools. However, once we condition on student characteristics including past performance in middle school, the STEM effect becomes quite small and, in many cases, statistically indistinguishable from zero. Moreover, exploring the STEM effects by gender, we find that females in STEMs generally perform better than females in Non-STEMs, although the gender *gap* is larger within STEMs than Non-STEMs across several outcomes. For blacks and Hispanics, in contrast, we find that the black-white and Hispanic-white gaps are *smaller* in STEM relative to Non-STEM schools across almost all outcomes. The Asian-white gap, however, is larger in STEM schools relative to Non-STEM schools.

The paper is organized as follows. In Section 2, we review literature on the role of high schools in performance in STEM fields and, in Section 3, we discuss the NYC school system in more detail, including definitions of STEM high schools, the high school choice system, and the examinations that New York City students take (Regents exams). In Section 4, we describe our data and, in Section 5, we explain our models and methods. We discuss our results in Section 6 and in Section 7, we conclude with observations about policy at the high school level as it concerns STEM performance.

2. Literature review: the role of schools in STEM participation and performance

While several explanations have been put forward for why students choose to pursue STEM courses and careers,

[2] One exception to this under-representation is medicine, where females earned 48.3 % of the MD's awarded in 2009–2010 (AAMC, 2011). At the same time, however, a 2011 US Commerce Department report finds that "although women fill close to half of all jobs in the U.S. economy, they hold less than 25 percent of STEM jobs. This has been the case throughout the past decade..." (Executive Summary, Economics and Statistics Administration), http://www.esa.doc.gov/Reports/women-stem-gender-gap-innovation, downloaded August 3, 2011.

[3] International comparison show that U.S. high school students score below many of their counterparts in other industrialized countries. Moreover, the National Assessment of Educational Progress (NAEP) reveals that only a quarter of students in grade 12 performed at or above proficient in mathematics (National Assessment of Educational Progress, 2005).

[4] Wai, Benbow, and Steiger (2010) show that while male–female ratios in mathematical reasoning of 7th grade students in the right tail (top 5% in ability) are substantially lower than 30 years ago, they have been stable over the last 20 years and still favor males. Further evidence from other tests such as the Advanced Placement subject tests, the American College Test and the American Mathematics Competition, supports these findings (ACT High School Profile Report: HS Graduating Class, 2007; College Entrance Examination Board, 2007; Ellison & Swanson, 2010). Fryer and Levitt (2009), in a recent study of mathematics learning among elementary school students, find a persistent and growing gender gap in mathematics achievement by 5th grade. In an analysis of several nationally representative data sets, Hedges and Nowell (1995) find that there is little average difference in the abilities of men and women, as measured by IQ and subject exams given to elementary and high school students. Hedges and Nowell, however, find that that there is greater variance in male ability and greater numbers of high achieving men.