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POLICY BRIEF

Examining High School and Postsecondary Outcomes of T-STEM Academies

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What We Studied

Inclusive STEM high schools, such as T-STEM Academies, are intended to broaden STEM opportunities by enrolling interested students from diverse backgrounds without imposing aptitude or prior achievement requirements and giving all their students STEM courses and real-world experiences to inspire and prepare them for entry into a STEM college major. The goal of this large-scale, longitudinal study of the effectiveness of inclusive STEM high schools was to ascertain whether ISHSs fulfill this purpose. Our research found that ISHS attendance increased the odds of completing key STEM courses (including calculus or pre-calculus) in high school and of students' being very interested in one or more STEM careers at the end of high school. These positive impacts were found for low-income, underrepresented minority, and female students as well as for students overall. ISHS attendance appeared to have a significant but small positive impact on Grade 11 math and science TAKS scores. Analysis of Texas postsecondary records found that T-STEM graduates were significantly more likely than similar students who attended other types of high schools in the matched comparison sample to be in a STEM bachelor's degree program two years after high school graduation.

The National Science Foundation funded SRI Education and Digital Promise to conduct *iSTEM: A Multi-State Longitudinal Study of the Effectiveness of Inclusive STEM High Schools* (DRL#1817513; DRL#1316920), examining the impact of inclusive STEM high schools (ISHS) on secondary and postsecondary student outcomes in three states, Texas, North Carolina, and Ohio. Inclusive STEM high schools are a large and growing investment across states to improve access to high-quality STEM education and preparation for STEM majors and careers for students from underrepresented groups, with T-STEM academies in Texas a prominent example of large-scale ISHS implementation. While a long tradition of academically selective STEM secondary education exists in the country, ISHSs seek to provide broad access to STEM education without screening for prior achievement. In Texas, North Carolina, and Ohio, many such schools are choice programs—students and families opt to attend an ISHS instead of their locally assigned high school. Student interest in STEM subjects is one driving factor in families' choosing ISHSs; other reasons include families' seeking higher-quality education overall, an academic culture, and a safe environment for their children, compared with the schools they are otherwise zoned to attend (Young et al., 2011). Thus, students attending ISHSs are not selected on the basis of prior academic strength, and ISHSs that are oversubscribed use a lottery system. Initially, T-STEMs were required to serve at least 50% economically disadvantaged students (T-STEM Blueprint, 2010) and current requirements stipulate that T-STEM academies target students at risk of dropping out and subpopulations "historically underrepresented in college courses" (p. 2, Texas Education Agency, 2019).

ISHSs prepare students from underrepresented groups for STEM majors by offering all students rigorous coursework, hands-on and problem-based learning experiences within and outside of school, academic and socioemotional supports, and exposure to STEM careers through internships, mentors, and other real-world learning experiences (Means et al., 2008, 2016). ISHSs as a policy initiative directly tackles inequity in economic and life outcomes that result from a lack of access to and participation in STEM preparation, majors, and careers for historically underrepresented

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populations—a challenge at the state and national levels (National Academies, 2005, 2011; National Science Board, 2014; President's Council of Advisors on Science and Technology [PCAST], 2010.

How We Analyzed the Data

Within the context of the broader three-state study, SRI Education and Digital Promise researchers set out to answer the following research questions about the impact of attending T-STEM academies:

- To what extent do STEM interests, activities, achievement, and expectations among 12th-graders attending inclusive STEM high schools differ from those of similar students attending regular comprehensive high schools?
- To what extent do STEM interests, activities, achievement, and expectations among 12th-graders from demographic groups underrepresented in STEM fields differ between those attending inclusive STEM high schools and those attending regular comprehensive high schools?
- To what extent does ISHS attendance result in a higher likelihood of students' taking STEM college courses and declaring STEM college majors compared with that of similar students attending regular comprehensive high schools?

The T-STEM sample included all T-STEMs that had a graduating class as of 2014. We followed those graduating seniors through their second postsecondary year to examine postsecondary outcomes. We also followed the 9th-graders of 2013-14 through their 12th-grade year to examine their high school outcomes.

To address the research questions, the research team used a quasi-experimental design, with propensity score matching techniques to identify one-to-one matches in comprehensive high schools for the T-STEM academies in our sample. Schools were matched on average 8th-grade state assessment scores for incoming 9th-grade students and student characteristics including percent underrepresented race/ethnicity, economically disadvantaged, English learner, and special education, as well as enrollment, small school size, charter status, and Program Improvement status. Students within T-STEM and comparison schools were further matched on demographics, prior (8th-grade) achievement on state assessments, and prior STEM interest (where available). Propensity score weights were used to ensure that T-STEM and comparison samples were within 0.25 standard deviation on all covariates. To further improve precision in the outcome estimates, all hierarchical models estimating the impact of attending ISHSs included school- and student-level covariates.

Student surveys administered during winter 2013-14 in T-STEM and comparison students' 9th-grade year approximated baseline measures of prior STEM interest and activities, identity in math and science, and academic orientation. Surveys of the same cohort administered in the spring of their 12th-grade year measured STEM learning experiences, STEM identity, academic self-perception, self-reported grades, interest in STEM majors and careers, and postsecondary plans. The 12th-grade survey was also administered in spring to the graduating class of 2014 at T-STEM and comparison schools.

The Texas Education Agency matched student survey data from the two cohorts of students to state administrative data that was then submitted to the Education Research Center for our analysis. Beyond the K12 data elements listed above, student-level longitudinal data used in our analyses included enrollment in 2-year and 4-year Texas postsecondary institutions for each semester after high school graduation through the spring of the second postsecondary year, STEM courses taken, and major declaration.

We used two-level (student and school) hierarchical models to estimate the effect of attending T-STEM schools on a range of academic, attitudinal, and behavioral outcomes at the end of high school for the 9th-grade cohort of 2014 and by the end of the second postsecondary year for the 12th-grade cohort of 2014. Detailed methods can be found in Means et al., 2017 and Means et al., 2018.

What We Discovered

High School Outcomes

Results for the 9th-grade cohort of 2014 are reported in Means et al., 2017. Refer to pages 694 through 703 and Tables 9 through 12 for Texas-specific results. Below is a summary of the statistically significant findings ($p < 0.05$).

Attitudes towards STEM subjects

- Latino and female students who attended an ISHS reported stronger science identity compared with matched peers.
- African American students at T-STEMs reported higher math efficacy than their matched peers.
- T-STEM students overall and Latino, African American, and female students in T-STEMs reported greater perseverance when faced with difficulty in math and science classes.

Interest in STEM majors and careers

- A higher proportion of T-STEM students overall and female students in T-STEMs planned to attend a 4-year college compared with matched peers.
- T-STEM students overall and Latino and female students reported a higher level of interest in STEM careers than their peers did.

High school STEM experiences

- T-STEM students were more likely to report that their math courses integrated content from other STEM subjects.
- Compared with their matched peers, T-STEM students reported higher teacher expectations and perceiving greater respect from their teachers.
- T-STEM students reported using more college readiness supports than did the matched comparison students, and having more conversations with counsellors about their academics and career plans.

High school achievement

- T-STEM students overall had higher math and science test scores on the grade 11 TAKS (spring 2013) than the comparison group, as did African American students in grade 11 science TAKs.
- Although statistically significant, the differences in test scores were not large.

Postsecondary Outcomes

Postsecondary outcomes for the 12-grade class of 2014 were reported in Means et al., 2018, also included with this policy brief. A summary of the statistically significant ($p < 0.05$) findings follow.

College enrollment

- Economically disadvantaged students from T-STEMs have higher odds of entering a Texas 4-year college immediately after high school (75% higher) or any time between the fall after high school graduation (2014) and the spring of their second postsecondary year (2016) (80% higher).

STEM college major declaration

- T-STEM graduates were almost three times more likely to declare a major in a core STEM field at a 4-year college within 2 years of high school graduation, compared with their matched peers.
- Economically disadvantaged, Latino, and female students were also more than three times as likely to declare a STEM major at a 4-year institution as their counterparts in the comparison group.

STEM course credits

- T-STEM graduates attending 4-year colleges completed a greater number of courses in core STEM subjects by the end of their second postsecondary year compared with comparison students also attending 4-year colleges.
- Latino, economically disadvantaged, and female students similarly completed a greater number of courses in core STEM subjects by the end of their second postsecondary year compared with comparison students also attending 4-year colleges.

Although here we highlight the significant differences on key outcomes, a substantial number across the full range of high school and postsecondary outcomes were not statistically different between the T-STEM sample and the comparison group. Nonetheless, across the two cohorts of students analyzed, attendance at T-STEM academies confer some specific advantages for students from underrepresented populations that demonstrate the promise of inclusive STEM high schools to broaden access to and participation in STEM education and ultimately careers.

Policy Recommendations

Policy implications of this study include:

- Regular analysis of postsecondary outcomes, specifically of STEM course-taking, major declaration, and completion, for underrepresented student groups using a rigorous comparative method can inform the extent to which T-STEM academies are increasing STEM access and equity.

- Continued monitoring of T-STEM academies' adherence to the T-STEM Blueprint can maintain T-STEM academies' mission of providing high-quality college preparatory STEM education for students who otherwise would not experience it at their local school. ISHS elements incorporated in the Blueprint includes providing all their students with rigorous math and science coursework and experiences that prepare them for STEM college majors; academic and social supports to help students succeed in rigorous math and science courses even if they entered high school with skills gaps; and extracurricular and school experiences that help students from underrepresented groups see themselves as future STEM professionals.

- With investment and technical assistance, comprehensive high schools should be able to implement T-STEM Blueprint features, providing more of their students from underrepresented groups with supportive and rigorous STEM education. Doing so is an area where further research would be helpful.

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