Evaluation of the Lone Star STEM program

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December 2024

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This report was developed under U.S. Department of Education Office of Elementary and Secondary Education, funded by a mid-phase Education Innovation and Research (EIR) grant, award number U411B180040.

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Abstract

The Lone Star Stem (LSS) program was designed to increase high-quality STEM education opportunities and outcomes for high-need students in Texas. The focus of the program was on implementing rigorous coursework that helps students gain the skills, postsecondary credentials, and experience necessary to embark on well-paying careers in STEM fields. The LSS program also sought to increase participation in STEM dual enrollment coursework, improve educational outcomes for high-need students; build capacity in schools to offer STEM coursework, and provide high-quality resources on best practices in implementing STEM coursework. The evaluation of the LSS program used a mixed-methods approach; the research team examined (a) the impact of the program through a cluster randomized trial with randomization at the school level, (b) the extent to which schools implemented the program as intended, (c) scale-up initiatives that can be applied across Texas as well as to other states, and (d) the cost per student of developing and implementing the program. There were no significant main effects of the program on any outcomes, but moderator analyses indicate that the program was effective for some groups of students. Students in the treatment group saw significantly better outcomes than students in control schools in the areas of academic success, staying in school, and career readiness. Specifically, the likelihood of persistence toward graduation was significantly higher for Asian students and Indigenous students, rates of completing a career and technical education (CTE) concentration were higher among Asian and Black students, and Algebra II pass rates were higher for Indigenous students. All schools met the threshold for adequate implementation of the program, but further examination identified barriers to implementation, especially among rural communities, such as the inability to retain computer science teachers. Although the LSS program successfully scaled up efforts to disseminate best practices in implementing STEM coursework, considerations for future developers include nuanced fidelity measures for early correction of implementation challenges, particular attention to the unique challenges faced by rural communities in implementing programs like LSS, and implications for accessibility of grant funding to participating schools.

Background

Jobs offering competitive wages and benefits increasingly require a postsecondary education, yet college completion rates have remained flat for decades (Bailey & Dynarski, 2011; Lee & Shapiro, 2023). Science, technology, engineering, and mathematics (STEM) jobs overwhelmingly offer above-average wages; according to the U.S. Census Bureau (2021), STEM workers on average earn wages 63% higher than the non-STEM workforce. Additionally, not only are STEM jobs on the rise faster than non-STEM fields (Bureau of Labor Statistics, 2024), half of STEM jobs require less than a bachelor's degree (Mishel et al., 2012; Rothwell, 2013), and unemployment rates within STEM are consistently about half the rate of the non-STEM workforce (U.S. Census Bureau, 2021). As such, boosting postsecondary attainment—especially in STEM-related fields—is increasingly important.

Currently, the United States lags behind several countries in postsecondary attainment, with just 42% of adults age 25 or older overall, 32% of African Americans, and 23% of Hispanics who have earned an associate's degree or higher (Bureau of Labor Statistics, 2024; Ryan & Bauman, 2016). Further, just 20% of bachelor's degrees in the United States are awarded in STEM fields, lagging behind countries like China, Russia, and Germany (Oliss et al., 2023). In addition, interest in STEM majors has declined and stopout in STEM fields is higher for women, students of color, and economically disadvantaged students than their traditionally overrepresented peers (National Center for Education Statistics, 2018; Smith et al., 2018).

Expanding STEM educational opportunities for traditionally underrepresented groups can increase innovation and creativity through a diversity of backgrounds and lived experiences, promote equity, and grow the pool of qualified STEM workers, which is needed to keep up with future demand in the field (National Center for Science and Engineering Statistics, 2023). Proportional representation of women, minorities, and first-generation college students in STEM education is critical to reach this goal. The Lone Star STEM (LSS) program addresses several of these problems that threaten shared long-term prosperity in the United States.

Funded by an Education Innovation and Research Mid-Phase grant and implemented through a partnership between the Texas Education Agency (TEA), Jobs for the Future (JFF), and the University of Texas at Austin Center for STEM Education, the LSS project was designed to increase high-quality STEM education opportunities and outcomes for high-need students, with a focus on implementing programs of study that help students gain the skills, postsecondary credentials, and experience necessary to embark on well-paying careers in STEM fields, including careers in computer science (CS) and cybersecurity. In addition, the project sought to expand the number of teachers statewide who are trained and certified to be able to teach in CS and cybersecurity pathways. LSS sought to expand these programs of study in rural, urban, and suburban districts, thereby increasing high-quality STEM opportunities for greater numbers of high-need students across Texas.

The primary goals of the project were to (a) increase high-need students' access to innovative STEM coursework, including CS, cybersecurity, and other in-demand STEM fields; (b) increase the number of and participation in STEM dual enrollment courses, with an emphasis on CS, cybersecurity, and other in-demand STEM fields; (c) improve achievement and educational outcomes for high-need students; (d) build schools' capacity to offer high-quality and innovative STEM, CS, and cybersecurity coursework, particularly in rural schools; and (e) codify, disseminate, and spread Lone Star STEM best practices in high-quality, innovative coursework and dual enrollment in in-demand STEM fields to other states.

This Report

The American Institutes for Research® (AIR®) conducted an independent evaluation of the LSS program on behalf of JFF and TEA. This final evaluation report comprises a rich description of the program and participating schools and students, followed by four discrete studies. First, we present findings from the impact analysis, which examines the impact of the LSS program on students' academic achievement, persistence toward graduation, and college readiness. Second, we discuss the implementation study, which examines the extent to which the LSS program was implemented as intended by schools randomly assigned to implement it, facilitators of and barriers to program implementation, and the extent to which the LSS program influences teacher perceptions of STEM. Third, we identify the LSS goals for bringing the program to scale and the extent to which those goals were met. Finally, we determine the cost-effectiveness of the program by presenting its cost-per-pupil annual expenditures. The report concludes with a general discussion of findings, implications, and recommendations for future practice.

Box 1. Lone Star Stem Program Expectations

- Establish an open enrollment STEM-focused program in a stand-alone campus or smaller within-school learning community with active feeder middle schools.
- Develop and implement a rigorous program of study (career pathways) in computer science, cybersecurity, or engineering and whole-school instructional shifts.
- Establish formally articulated relationships with business/industry and college (2- or 4-year) partners aligned to STEM careers.
- Develop work-based learning opportunities at every grade level aligned to student interest, regional employer needs, and program of study industry certifications/credentials.
- Implement wraparound strategies and services in and out of school for success in rigorous academic and work-based learning experiences.
- Serve Grade 9 in the first year of implementation, expand to Grades 6–12 or 9–12 throughout the project, and enroll students who are at risk of dropping out.

The LSS Program

With support from TEA, JFF, and the University of Texas at Austin Center for STEM Education, schools implementing the LSS program had to meet several requirements (see Box 1). In the short term, LSS students were expected to learn key concepts and skills through the developed career pathways, perform better on state assessments, stay in school and on track to graduation, pass college readiness assessments, enroll in courses to obtain college credit, and earn CTE concentrations. In addition, LSS students were expected to demonstrate increased engagement with and confidence in learning STEM subjects.

In the long term, the program sought to help students retain fundamental knowledge of STEM content, STEM fluency skills, and confidence in their ability to learn in these areas. With these skills and knowledge, students were expected to be more likely to pursue and succeed in advanced coursework in STEM, CS, or cybersecurity. Ultimately, students were expected to be more likely to pursue STEM careers, be better prepared for these careers, and be more successful in these careers.

To identify campuses that offered high-quality educational opportunities and exposure to postsecondary experiences, TEA developed the College and Career Readiness School Models (CCRSM) designation for high schools. Schools across the state could apply for a CCRSM designation indicating that attending students could participate in courses to develop technical skills, earn college credit while in high school, and pursue in-demand career pathways. At the start of the grant, all participating schools held one of three designations: Early College High School (ECHS), Pathways in Technology Early College High School (P-TECH), or Texas Science Technology Engineering Mathematics (T-STEM). TEA provided web resources and a network of schools for support and continuous improvement. The T-STEM designation was discontinued in summer 2023, when TEA shifted policy to help all campuses develop and maintain a STEM focus.

The LSS program was implemented in three phases, each lasting one academic year:

Phase I: Planning Phase. During the planning phase, treatment schools received funding to develop an implementation proposal for an LSS Academy. Implementation proposals were required to be based on the program guidelines. Treatment schools were expected to work with the technical assistance staff and coaches to revise and improve their proposals until the proposals met all expectations of the program. A treatment school that failed to meet one or more of the LSS Academy eligibility requirements by the end of the planning phase (i.e., after one academic year) did not receive funding opportunities to implement or continue an LSS Academy.

Phase II: Implementation Phase. All treatment schools that received approval for their implementation proposals received 1 year of implementation funding.

Phase III: Continuation Phase. Treatment schools that met the expectations of TEA outlined in the Texas Science, Technology, Engineering and Mathematics Blueprints during the implementation year and that developed an approved sustainability plan received an additional year of funding to support continued implementation. Treatment schools that did not meet the expectations no longer received funding from TEA. Exhibit 1 provides a timeline for when each cohort was in each phase of the program.

Exhibit 1. Project Phase and Program Years by Cohort

<table>
<tr><th rowspan="2">Phase</th><th colspan="5">Year</th></tr>
<tr><th>2019</th><th>2020</th><th>2021</th><th>2022</th><th>2023</th></tr>
<tr><td rowspan="2">Planning</td><td colspan="2">Cohort 1</td><td></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td></td><td colspan="2">Cohorts 2/3</td></tr>
<tr><td rowspan="2">Implementation</td><td rowspan="2"></td><td colspan="2">Cohort 1</td><td></td><td rowspan="2"></td></tr>
<tr><td></td><td colspan="2">Cohorts 2/3</td></tr>
<tr><td rowspan="2">Continuation</td><td rowspan="2"></td><td rowspan="2"></td><td colspan="2">Cohort 1</td><td></td></tr>
<tr><td></td><td colspan="2">Cohorts 2/3</td></tr>
</table>

The evaluation of the LSS program also included a set of control schools. Schools that were not randomly assigned to the treatment group to develop an LSS Academy served as the control group. Each control school received $3,333 per year for professional development to support teacher certification in CS and cybersecurity or for professional development to support integrated STEM education. Because comparison schools were free to seek out the usual or typical professional development in these subject areas, these schools conducted business as usual and did not receive any professional development services specific to Lone Star STEM.

Logic Model

AIR worked with JFF and TEA to develop a logic model that described the program design and intended outcomes. The logic model for the LSS program is presented in Exhibit 2. As shown, LSS has six key components: site visits and coaching calls, LSS resources, technical assistance, professional development, school leadership initiatives, and teacher participation.

Site visits/coaching calls. The site visits and coaching calls were intended to provide LSS schools with coaching materials and information about grant requirements. These site visits and coaching calls were conducted during each cohort’s planning year. Cohort 1 schools received individual in-person site visits from TEA and JFF staff during their planning year, and Cohorts 2/3 received virtual coaching calls. The original intent was that all schools would receive in-person site visits; however, the change to virtual coaching calls for Cohorts 2/3 was made to accommodate TEA and JFF staff who were unable to travel to school sites during the 2020–21 fall/winter semester due to the COVID-19 pandemic. The site visits and coaching calls covered the same content, and all schools were given access to the support modules available on the LSS virtual platform developed by TEA and JFF. TEA also provided each cohort with a package of planning tools and templates to support planning and implementation. These resources were provided throughout each cohort's continuation year.

LSS resources. The LSS program resources from JFF and TEA were available to all treatment schools. Resources included four online modules that provided LSS schools with information and support for implementation of the LSS model with a focus on STEM instructional shifts, design-based curriculum, and project- or problem-based learning, plus a TEA-hosted website that provided schools with information and guidance on additional STEM resources.

Technical assistance. Throughout each cohort's planning year and continuation year, JFF provided Lone Star STEM schools with technical assistance to build capacity, review career pathways, and create connections among participating schools. Technical assistance opportunities included webinars covering a variety of topics (e.g., ensuring components of programs of study and career pathways were present and aligned, strategically aligning dual enrollment courses and career pathways, using tools and resources to assess school capacity, analyzing labor market data to identify promising occupations in CS, cybersecurity, and/or engineering), coaching calls for all cohorts, and peer learning network opportunities within scheduled office hours.

Professional development. Lone Star STEM schools were required to offer professional development focused on STEM integration to all teachers in the school. Applicable trainings could have included those developed by regional education service centers and offered to LSS schools at a low cost and/or comparable trainings from another service provider. The required professional development categories from the program guidelines were as follows:

- Project-based learning
- Engineering design challenges and inquiry-based learning
- Technological literacy and integration
- Data-driven, differentiated, student-centric instruction
- Content knowledge in STEM fields
- Disciplinary literacy instruction
- Collaborative learning

In addition, Lone Star STEM schools had access to professional development for teachers in CS and cybersecurity, including guidance on content and curriculum through the University of Texas at Austin Center for STEM Education. Box 2 describes offerings that schools implementing the LSS program had access to at no additional cost to the school.

BOX 2. RESOURCES AVAILABLE TO LSS SCHOOLS AT NO ADDITIONAL COST

1. Registration for Foundations of Computer Science for Teachers online course (computer science)
2. Registration for Cyber Encounters (cybersecurity)
3. Attendance at the summer We Teach Computer Science Summit to support teachers in obtaining their computer science teaching certification (up to two teachers per school per year included)
4. We Teach Computer Science summer certification preparation course
5. An annual license to the We Teach Computer Science for High School curriculum
6. An annual license to the We Teach AP CSA curriculum
7. Monthly cybersecurity and computer science webinars

Additional course offerings from the University of Texas at Austin in CS and cybersecurity were offered to teachers and schools for purchase using grant planning or implementation funds. These included Introduction to Programming I and II and a Lone Star STEM Computer Science intensive course for teachers in schools pursuing CS pathways, and Introduction to Programming I and II, Cybersecurity 101, and a Lone Star STEM Cybersecurity Intensive for teachers in schools pursuing cybersecurity pathways. Schools could also receive individual support from Expanding Pathways in Computing at the University of Texas at Austin staff for a daily fee, payable through grant funds or other means.

School leadership initiatives. LSS school leadership teams were expected to participate in the site visits or coaching calls offered by JFF; establish open-enrollment STEM-focused LSS Academies at their school in which they instituted a rigorous program of study (career pathway) in CS, cybersecurity, or engineering; offer whole-school STEM integration professional development; establish and maintain a partnership with at least one postsecondary institution; and establish and maintain work-based learning opportunities aligned with STEM careers.

Teacher participation. All teachers at LSS schools were expected to attend the professional development training focused on whole-school STEM integration. LSS Academy teachers were expected to participate in professional development related to CS, cybersecurity, or engineering and to become certified to teach these courses.

In addition to the key components, the logic model in Exhibit 2 shows the mediators that change students' skills and STEM mindsets as well as the short- and long-term outcomes expected as a result of LSS program implementation.

Exhibit 2. LSS Logic Model

Key components

Inputs

Site Visits/Coaching Calls: Coaching materials and information to meet grant requirements.

Lone Star STEM Resources: Virtual resources on planning and implementing T-STEM and Lone Star STEM models with a focus on instructional shifts. (*Jobs for the Future*, *Texas Education Agency*)

Technical Assistance: Technical assistance to build capacity, review pathways, and create connections between participating schools. (*Jobs for the Future*)

Professional Development: Professional development and curriculum guidance for teachers in computer science/cybersecurity/ engineering. (*University of Texas at Austin Center for STEM Education, education service centers*)

Output/participation

School Leadership Initiatives

- Establish an open-enrollment, STEM-focused program.
- Institute a rigorous program of study in computer science/ cybersecurity/ engineering and whole-school instructional shifts.
- Establish work-based learning aligned to STEM careers.
- Establish student academic support services.

Teacher Participation

- Attend professional development for instructional shifts.
- Become certified to teach computer science and cybersecurity courses.

Mediators

School Leadership: Allocation of supports and resources is aligned to strengthen career pathways.

Teachers: Through professional development and collaboration with leadership and colleagues, instruction and knowledge of how to support students as individual learners of computer science/ cybersecurity/ engineering is strengthened.

Student engagement in hands-on learning experiences increases. Students are exposed to enhanced curriculum content and participate in activities that help them gain more accurate information about STEM careers.

Student learning of computer science, cybersecurity, and engineering concepts and skills is enhanced by new curriculum, instruction, and overall structure of programs.

Student interest and motivation are increased by their participation; they more concretely understand what it may mean to pursue further coursework or careers in STEM.

Student outcomes

Short term

Students learn key concepts and skills through developed career pathways, perform better on state assessments, pass college readiness assessments, remain in school and on track to graduate, and complete career and technical education concentrations.

Measures:

- Algebra I end-of-course (EOC) exam
- English I EOC exam
- English II EOC exam
- Persistence (continued enrollment)
- On track to graduate
- Algebra II course credit
- Texas Success Initiative (TSI) Reading
- TSI Mathematics
- Dual enrollment (course completion)
- STEM dual enrollment (course completion)
- Completion of career and technical education concentrations

In addition, students report higher engagement with and confidence in learning STEM subjects. **(Measures: confidence in STEM and STEM fluency skills reported on survey)**

Long term

Students better **retain**

- **fundamental knowledge** in STEM content,
- **skills** related to STEM fluency, and
- **confidence** in their learning abilities in these areas.

With these skills and knowledge, students are more likely to **pursue**—and be successful in—**advanced** computer science/cybersecurity/ engineering **coursework**.

Students are more likely to pursue STEM **careers**, be better prepared for these careers, and be more successful in these careers.

Impact Study

The study team conducted a summative experimental evaluation of the LSS intervention's impact using cluster-level randomization to assign participating schools to treatment and control conditions. These analyses estimate the impact of school-level implementation of LSS on students' academic achievement, persistence toward high school graduation, and college and career readiness by comparing students in LSS schools with students in control schools. The impact evaluation of the LSS program is guided by 13 research questions designed to examine the impact of the program on students' academic achievement, progress toward graduation, and college and career readiness. These questions are listed in Exhibit 3.

Exhibit 3. Research Questions for the Study

Impact analysis	Research question	Domain
Student impacts (confirmatory)	1. What is the impact of Lone Star STEM compared to business as usual on high school students' STAAR Algebra I end-of-course assessment scores?	Algebra
	2. What is the impact of Lone Star STEM compared to business as usual on high school students' likelihood of earning Algebra II course credits?	
	3. What is the impact of Lone Star STEM compared to business as usual on high school students' STAAR English I end-of-course assessment scores?	General literacy achievement
	4. What is the impact of Lone Star STEM compared to business as usual on high school students' STAAR English II end-of-course assessment scores?	
	5. What is the impact of Lone Star STEM compared to business as usual in high school on staying in school?	Staying in school
	6. What is the impact of Lone Star STEM compared to business as usual on high school students staying on track to graduate?	Progressing in school
	7. What is the impact of Lone Star STEM compared to business as usual on high school students earning dual enrollment course credits?	College readiness
	8. What is the impact of Lone Star STEM compared to business as usual on high school students earning STEM dual enrollment course credits?	
	9. What is the impact of Lone Star STEM compared to business as usual on high school students' likelihood of passing the TSI math assessment?	
	10. What is the impact of Lone Star STEM compared to business as usual on high school students' likelihood of passing the TSI reading assessment?	
	11. What is the impact of Lone Star STEM compared to business as usual on high school students completing a career and technical education concentration?	Career readiness

Impact analysis	Research question	Domain
Moderator impacts (exploratory)	12. How are the effects of Lone Star STEM on student outcomes moderated by the following: – Student factors (e.g., race/ethnicity, economic disadvantage) and academic performance at baseline – School factors (e.g., percentage racial/ethnic minority students, geographic location, percentage economically disadvantaged students)	
Mediator impacts (exploratory)	13. Is there a statistically significant relationship between fidelity of implementation and student outcomes?	

Note. STAAR = State of Texas Assessments of Academic Readiness; TSI = Texas Success Initiative.

The evaluation plan for this impact study was preregistered in the Registry of Efficacy and Effectiveness Studies under Registry ID 5700.1v2.

Design and Measures

Design

AIR conducted the impact evaluation as a multicohort cluster randomized controlled trial to investigate the effect of LSS on student outcomes. During summer 2019 (Cohort 1), summer 2020 (Cohort 2), and fall 2020 (Cohort 3), participating schools were randomly assigned to either a treatment or a control condition. Although Cohort 2 and 3 schools were randomized separately, they are discussed as combined Cohorts 2/3 throughout much of the report because randomization of the schools in these cohorts followed the same implementation timelines. Details of the process for randomization are provided in the appendix.

Measures

To examine the impact of the LSS program on academic achievement, persistence toward graduation, and college readiness, AIR used data files from TEA's State of Texas Assessments of Academic Readiness (STAAR) and the Public Education Information Management System.

State of Texas Assessments of Academic Readiness. The STAAR test is the state-mandated achievement test that is based on the Texas State Standards. In an independent evaluation of the validity and reliability of STAAR end-of-course (EOC) tests commissioned by the State of Texas, researchers found evidence for (1) alignment with Texas Essential Knowledge and Skills (TEKS) across all subject areas and grades, suggesting strong content validity; (2) all EOC tests had reliability estimates higher than 0.89; and (3) each grade and subject is strongly associated with on-grade performance (see http://tea.texas.gov/sites/default/files/TechDigest_2017_2018_Chapter4_r3_tagged.pdf). As shown in Exhibit 4, AIR used scores on STAAR English I, English, II, and Algebra I EOC tests as outcomes in the impact analyses.

Student persistence in school/progress to next grade. Year-to-year persistence was estimated using student enrollment files maintained by TEA.

On-track to graduate. In Texas, students graduate from high school under the Foundation High School Program, which requires that students earn 26 credits, including earning an endorsement in one of five areas—STEM, Art and Humanities, Business and Industry, Public Services, or Multidisciplinary—unless they receive permission from their parents to drop to a graduation plan that allows students to graduate with only 22 credits. To determine whether students were on track to graduate, AIR assessed whether students had attained the following milestones in each grade: at least 6.5 credits by the end of Grade 9, 13.0 credits by the end of Grade 10, and 19.5 credits by the end of Grade 11.

Algebra II course credit. In Texas, students are not required to complete Algebra II in order to graduate from high school. However, it is an admissions requirement for all Texas 4-year college and universities. AIR used extant course completion data to determine whether students had earned course credit for Algebra II.

Career and technical education concentrator. AIR used extant course completion data to determine whether students were enrolled in two or more CTE courses.

Texas Success Initiative Reading and Math assessments. The Texas Success Initiative (TSI) assessments are part of the Texas Success Initiative enacted by the Texas legislature and designed to determine students' readiness for college-level coursework in the general areas of reading, writing, and mathematics. The TSI, or one of its exemptions, is required of Texas students entering a Texas college or university. The TSI is administered through the College Board's Accuplacer digital platform. Universities, community colleges, school districts, and high school campuses can request to administer the TSI to students.

Dual enrollment and STEM dual enrollment. AIR used extant course completion data to determine whether students were enrolled in any dual enrollment courses as well as whether students were enrolled in STEM dual enrollment courses.

Exhibit 4. Outcome Domains, Measures, Sources, and Grades and Years When Each Were Measured

Domain	Outcome measure	Data source	Grade 10 Spring ‘21 (C1) Spring ‘22 (C2/3)	Grade 11 Spring ‘22 (C1) Spring ‘23 (C2/3)	Grade 12 Spring ‘23 (C1)
Algebra	Algebra II course credit	PEIMS		●	●
General literacy achievement	English II end-of-course test	STAAR		●	
Staying in school	Persistence (continued enrollment)	PEIMS	●	●	●
Progressing in school	On track to graduate (course completion)	PEIMS	●	●	
College readiness	TSI Reading	PEIMS		●	●
	TSI Mathematics	PEIMS		●	●
	Dual enrollment (course completion)	PEIMS		●	●
	STEM dual enrollment (course completion)	PEIMS		●	●
Career readiness	CTE concentrations (2+ courses)	PEIMS		●	●

Note. C1 = Cohort 1; C2/3 = Cohorts 2/3; CTE = career and technical education; PEIMS = Public Education Information Management System; STAAR = State of Texas Assessments of Academic Readiness; TSI = Texas Success Initiative.

Sample Sizes and Attrition

Attrition

In Cohort 1, 30 schools were randomized to treatment or control; in Cohorts 2/3, 18 schools were randomized to treatment or control. As of November 2022, the following schools had dropped out of the study: six treatment and six control schools from Cohort 1, two treatment and two control schools from Cohort 2, and one treatment and three control schools from Cohort 3. A total of 28 schools—15 treatment and 13 control schools—remain in the study. Overall, school-level attrition for the study was about 42%, and school-level differential attrition was approximately 8%, which is considered high attrition according to the What Works Clearinghouse (WWC; 2022; see Exhibit 5).

Exhibit 5. Overall and Differential Attrition for the Sample

	Randomized	Attritted	Remaining	% of attrition
Overall	48	20	28	42%
Condition				
Treatment	24	9	15	38%
Control	24	11	13	46%
Differential attrition				8%

Across cohorts, there were 5,632 students total in the analytic sample, with 2,926 students in Cohort 1 and 2,706 students in Cohorts 2/3. Across cohorts, there were 3,584 students in the treatment group (Cohort 1 n = 1,129; Cohorts 2/3 n = 2,455) and 2,048 students in the control group (Cohort 1 n = 1,797; Cohorts 2/3 n = 251). There were some limitations on outcome availability depending on the cohort (Algebra I and English I were available only for Cohorts 2/3 because they were Grade 9 students in 2019–20 and did not take these exams; CTE completion is only for Cohort 1 because Cohorts 2/3 were still in high school at the completion of the grant. See Exhibit 6 for the analytic sample size for each outcome of interest for both the treatment and control groups.

Exhibit 6. Analytic Sample Size, by Outcome of Control and Treatment Groups

Outcome	Analytic sample size	
	Control group	Treatment group
Algebra I	195	1,484
Algebra II	1,537	2,825
English I	202	2,304
English II	1,694	3,167
Persistence	2,033	3,455
On track	2,033	3,455
Dual credit	2,048	3,584
STEM dual credit	2,048	3,584
TSI Math	515	807
TSI Reading	515	807
Career and technical education completion	1,797	1,129

Note. TSI = Texas Success Initiative. TSI score sample sizes are lower because this exam is not required for all students.

Data Analysis and Findings

Because of the decision to estimate the impacts of the LSS program using a quasi-experimental design, the WWC requires that treatment and control groups be statistically equivalent on measures taken before program implementation. Exhibit 7 outlines the measures that were used to establish baseline equivalence for each outcome.

Exhibit 7. Measures Used to Establish Baseline Equivalence for Each Confirmatory Outcome

<table>
<tr><th rowspan="2">Domain</th><th rowspan="2">Outcome measure</th><th>Measure(s) used to establish baseline equivalence</th></tr>
<tr><th>Spring 2019 (C1)
Spring 2021 (C2/3)</th></tr>
<tr><td>Algebra</td><td>Algebra II course credit</td><td>STAAR Grade 8 Math (C1)
STAAR Algebra I EOC test (C2/3)</td></tr>
<tr><td>General literacy achievement</td><td>English II EOC test</td><td>STAAR Grade 8 Reading (C1)
STAAR English I EOC test (C2/3)</td></tr>
<tr><td>Staying in school</td><td>Persistence (continued enrollment)</td><td rowspan="7">Achievement
• STAAR Grade 8 Math (C1)
• STAAR Grade 8 English (C1)
• STAAR Algebra I EOC test (C2/3)
• STAAR English I EOC test (C2/3)
Socioeconomic status/demographics
• Economic disadvantage</td></tr>
<tr><td>Progressing in school</td><td>On track to graduate (course completion)</td></tr>
<tr><td rowspan="4">College readiness</td><td>TSI Reading</td></tr>
<tr><td>TSI Mathematics</td></tr>
<tr><td>Dual enrollment</td></tr>
<tr><td>STEM dual enrollment (course completion)</td></tr>
<tr><td>Career readiness</td><td>Career and technical education concentrations (2+ courses)</td></tr>
</table>

Note. C1 = Cohort 1; C2/3 = Cohorts 2/3; EOC = end of course; TSI = Texas Success Initiative; STAAR = State of Texas Assessments of Academic Readiness.

Baseline Equivalence

At the time of randomization, 6,395 students were part of Cohort 1 and 4,233 students were part of Cohorts 2/3. Exhibit 8 highlights the demographic and state assessment characteristics of students in each cohort at baseline. Cohorts 2/3 had a higher proportion of students who were economically disadvantaged, bilingual emergent, and in special education than Cohort 1. Cohorts 2/3 also had a higher proportion of Black students and a smaller proportion of students who met STAAR math or reading standards

Exhibit 8. Student Characteristics of Randomized Sample at Baseline

Domain	Cohort 1	Cohorts 2/3
Race/ethnicity	**%**	**%**
Asian	2.16	3.25
Black	11.70	15.75
Hispanic	71.83	71.83
Indigenous[a]	15.28	9.15
White	73.89	74.26
Student characteristics	**%**	**%**
Female	48.25	49.24
Bilingual emergent	18.07	22.12
Economically disadvantaged	70.02	74.61
Met STAAR Standards	**%**	**%**
STAAR Grade 7 or 8 Math	38%	10%
STAAR Grade 7 or 8 Reading	46%	31%

Note. STAAR = State of Texas Assessments of Academic Readiness. [a]Combined American Indian and Hawaiian/Pacific Islander.

Following WWC guidelines, the AIR study team assessed baseline equivalence on key demographic and achievement variables using Hedges' *g* for continuous variables (i.e., math and reading scores) and Cox's index for dichotomous variables (i.e., economic disadvantage, gender, bilingual emergent, special education, and race).

Exhibits 9 through 11 present sample descriptive statistics and the effect size differences between the treatment and control groups for each assessment, by cohort and combined. Effect size differences were calculated using group percentages, means, standard deviations, and sample sizes. Effect size differences for the math and reading scores for all cohorts met WWC requirements; that is, the absolute values of the effect sizes were smaller than 0.25. For all cohorts, the differences in percentages of Asian students exceeded the WWC threshold of 0.25. For Cohort 1, the difference in percentage of bilingual emergent students exceeded the WWC threshold of 0.25 (Exhibit 9).

Exhibit 9. Baseline Differences in Student Demographic and Academic Characteristics, Cohort 1

Domain	Treatment	Control	Difference
Race/ethnicity	**%**	**%**	**Effect size**
Asian	0.97	2.34	-0.54[b]
Black	5.14	12.97	-0.61[b]
Hispanic	83.97	66.44	-0.59[b]
Indigenous[a]	13.11	13.86	-0.04
White	82.46	74.23	0.30
Student characteristics	**%**	**%**	**Effect size**
Female	47.39	48.30	-0.02
Bilingual emergent	21.97	12.69	0.40[b]
Economically disadvantaged	77.86	73.01	0.16
STAAR Math and Reading	**Mean (SD)**	**Mean (SD)**	**Effect Size**
STAAR Grade 7 or 8 Math	1564.98 (264.83)	1542.73 (295.76)	0.08
STAAR Grade 7 or 8 Reading	1671.54 (149.49)	1665.78 (177.17)	0.03

Note. STAAR = State of Texas Assessments of Academic Readiness; SD = standard deviation. [a]Combined American Indian and Hawaiian/Pacific Islander. [b]Denotes a baseline equivalence > |0.25|.

For Cohorts 2/3, there were large differences among the treatment and control groups in almost all the demographic groups except Black students. This lack of equivalence may be due to the inability to recruit schools because of the COVID-19 pandemic (Exhibit 10).

Exhibit 10. Baseline Differences in Student Demographic and Academic Characteristics, Cohorts 2/3

Domain	Treatment	Control	Difference
Race/ethnicity	**%**	**%**	**Effect size**
Asian	0.98	0.40	0.55[b]
Black	14.54	19.92	-0.23
Hispanic	78.57	79.68	-0.04
Indigenous[a]	8.64	8.37	0.02
White	78.21	71.31	0.22
Student characteristics	**%**	**%**	**Effect size**
Female	48.92	51.39	-0.06
Bilingual emergent	21.51	8.37	0.67[b]
Economically disadvantaged	77.23	70.52	0.21

Domain	Treatment	Control	Difference
STAAR Math and Reading	**Mean (SD)**	**Mean (SD)**	**Effect Size**
STAAR Grade 7 or 8 Math	1569.24 (192.83)	1567.64 (155.35)	0.01
STAAR Grade 7 or 8 Reading	1617.29 (132.10)	1622.19 (142.29)	-0.04

Note. STAAR = State of Texas Assessments of Academic Readiness; SD = standard deviation. [a]Combined American Indian and Hawaiian/Pacific Islander. [b]Denotes a baseline equivalence > |0.25|.

When all three cohorts were combined, students of Asian descent, Hispanic students, and bilingual emergent students were not equally represented between the treatment and control groups, with the control group having significantly more students of Asian descent and the treatment group having significantly more Hispanic and bilingual emergent students (Exhibit 11).

Exhibit 11. Baseline Differences in Student Demographic and Academic Characteristics, All Cohorts

Domain	Treatment	Control	Difference
Race/ethnicity	**%**	**%**	**Effect size**
Asian	0.98	2.10	–0.47[b]
Black	11.58	13.82	–0.12
Hispanic	80.27	68.07	0.39[b]
Indigenous[a]	10.04	13.18	–0.19
White	79.55	73.88	0.19
Student characteristics	**%**	**%**	**Effect size**
Female	48.44	48.68	–0.01
Bilingual emergent	21.65	12.16	0.42[b]
Economically disadvantaged	77.43	72.71	0.15
STAAR Math and Reading	**Mean (SD)**	**Mean (SD)**	**Effect size**
STAAR Grade 7 or 8 Math	1,567.87 (218.60)	1,545.08 (285.53)	–0.09
STAAR Grade 7 or 8 Reading	1,634.77 (140.23)	1,661.67 (174.61)	0.18

Note. STAAR = State of Texas Assessments of Academic Readiness; SD = standard deviation. [a]Combined American Indian and Hawaiian/Pacific Islander. [b]Denotes a baseline equivalence > |0.25|.

Baseline equivalence for the analytic sample for each of the 11 main outcomes can be found in Appendix B.

Program Effects

As a result of the high attrition of schools, the evaluation team opted to pursue a quasi-experimental design for the study. Because some covariates did not meet baseline equivalence, we employed propensity score matching to adjust for these differences.

Our final analytic model is represented below. It is a two-level model with students nested within schools. For Research Questions (RQs) 1 through 11, evidence of Lone Star STEM's impact on student outcomes was based on the statistical significance of the estimated parameter (γ_2).

$$Y_{ij} = \gamma_0 + \gamma_1 Cohort_j + \boldsymbol{\gamma_2 LS.STEM_j} + \gamma_3 \boldsymbol{Z}_j + \beta_1 \boldsymbol{X}_{ij} + \mu_{0j} + e_{ij}$$

Where:

Y_{ij}	=	value on the outcome (*Y*) for student *i* in school *j*
γ_0	=	adjusted mean outcome for comparison school *j* in Cohort 1
γ_1	=	adjusted impact of cohort on student outcomes
$Cohort_j$	=	vector of cohort indicators (Cohort 1 [0] vs. Cohorts 2/3 [1])
$\boldsymbol{\gamma_2}$	=	adjusted impact of treatment on student outcomes
$\boldsymbol{LS.STEM_j}$	=	vector of treatment indicators (Lone Star STEM [1] vs. business as usual [0])
γ_3	=	adjusted impact of school-level aggregates on student outcomes
$\boldsymbol{Z}_j$	=	matrix of school-level aggregates of student covariates
β_1	=	adjusted effect of student-level covariates on student outcomes
$\boldsymbol{X}_{ij}$	=	matrix of student-level covariates
μ_{0j}	=	unmodeled residual for school *j*
e_{ij}	=	unmodeled residual for student *i* in school *j*

To assess whether the effect of LSS on student outcomes was moderated by student covariate (RQ12), we added interaction terms to the hierarchical linear model presented above between the treatment indicator and the student characteristic of interest. The moderator effects were estimated by the following model:

$$Y_{ij} = \gamma_0 + \gamma_1 Cohort_j + \gamma_2 LS.STEM_j + \gamma_3 Z_j + \beta_1 X_{ij} + \boldsymbol{\delta_{1j} LS.STEM * X_{ij}} + \mu_{0j} + e_{ij}$$

where $\boldsymbol{LS.STEM * X_{ij}}$ represents a matrix of treatment-by-covariate indicators. Evidence of moderator effects on the impact of LSS on student outcomes was based on the statistical significance of the estimated parameter of the interaction effect ($\boldsymbol{\delta_{1j}}$).

For RQ13, which explored the relationship between fidelity of implementation and student outcomes, we modified the main effect model by substituting the matrix of treatment status indicators with a matrix of fidelity of implementation scores. The effects of fidelity of implementation were estimated by the following model:

$$Y_{ij} = \gamma_0 + \gamma_1 Cohort_j + \boldsymbol{\gamma_2 Imp.Fid_j} + \gamma_3 Z_j + \beta_1 X_{ij} + \mu_{0j} + e_{ij}$$

where $\boldsymbol{Imp.Fid_j}$ represents a matrix of implementation fidelity scores for schools that implemented LSS. Evidence of the impact of implementation fidelity on student outcomes was based on the statistical significance of the estimated parameter ($\boldsymbol{\gamma_2}$).

In each model, we controlled for student-level covariates (gender, economic disadvantage status, special education status, emergent bilingual status, race/ethnicity, baseline math and/or reading achievement), the interaction between program participation and student covariates, school-level aggregates, cohort, and the proportion of economically disadvantaged students, students receiving special education services, and emergent bilingual students.

Analysis Limitations

It is crucial to note some of the limitations of the analysis approach, which fall into two main categories.

Concerns with missing data. Algebra I and English I were available only for Cohorts 2/3 because Cohort 1 did not take standardized tests in spring 2020. CTE completion is only for Cohort 1 because that data point can be collected only after graduation; students in Cohorts 2/3 had not graduated by the end of the grant. Some TSI scores are missing because this exam is not required for all students. In addition, some subgroup analyses had very small sample sizes between conditions (e.g., fewer than n = 15). We address this issue through pairwise deletion and use of propensity score weights.

Some analysis models would not converge. This was because of sparse data and overly complex models and was particularly problematic for analytic models with binary outcomes (i.e., logistic regression models). These issues were addressed by combining categories across covariates model simplification (i.e., dropping covariates) and adjusting estimation procedures.

Findings

RQ1–11. What is the impact of Lone Star STEM compared to business-as-usual on high school students' academic achievement, staying on track to graduate, and college and career readiness?

Our analyses revealed, overall, no significant main effects of the LSS program on any outcomes measured. Exhibit 12 details the analysis for each outcome.

Exhibit 12. Main Effects for the Impact of LSS on Academic Achievement, Persisting in School, and College and Career Readiness Outcomes

	Comparison group				Treatment group							
	Sample size				Sample size							
Outcome	# of clusters	# of students	Mean	SD	# of clusters	# of students	Mean	SD	Estimate	SE	Z-stat	*p*-value
Algebra I score	4	195	3828	543	6	1,484	3709	382	–309	271	–1.14	0.25
Algebra II pass	13	1,537	0.86	0.34	14	2,825	0.86	0.35	0.03	0.02	1.18	0.24
English I score	4	202	3935	473	6	2,304	3936	407	–371	601	–0.62	0.54
English II score	12	1,694	4085	449	15	3,167	4025	484	–13.50	102	–0.13	0.90
Persistence	13	2,033	0.85	0.37	14	3,455	0.88	0.33	0.01	0.01	0.49	0.62
On track	13	2,033	0.76	0.43	14	3,455	0.74	0.44	–0.03	0.04	–0.75	0.46
Dual credit hours	13	2,048	6.53	13.60	15	3,584	7.20	14.50	5.65	5.12	1.10	0.27
STEM dual credit	13	2,048	2.81	8.25	15	3,584	2.40	6.45	2.46	2.28	1.08	0.28
TSI Math score	13	515	0.41	0.49	15	807	0.37	0.48	0.06	0.17	0.36	0.72
TSI Reading score	13	515	0.62	0.49	15	807	0.60	0.49	–0.05	0.14	–0.32	0.75
Completed CTE concentration	9	1,797	0.38	0.49	9	1,129	0.33	0.47	0.06	0.07	0.89	0.37

Note. SD = standard deviation; TSI = Texas Success Initiative; CTE = career and technical education.

RQ12. How are the effects of the Lone Star STEM on student outcomes moderated by student- and school-level characteristics?

At the student level, the study team examined moderating effects of student race/ethnicity, gender, economic disadvantage, and prior academic achievement. Race/ethnicity emerged as a moderating factor in five contrasts. Among Indigenous students, the LSS program had a significant impact on the likelihood of passing Algebra II ($p = 0.01$) compared to Indigenous students in control schools and on the likelihood of persistence, or staying in school ($p < 0.001$). Persistence was also significantly more likely among Asian students in the LSS program ($p = 0.01$) compared to the control group, in addition to the likelihood of completing a CTE concentration ($p < 0.001$). Finally, Black students in the LSS program were also more likely than their peers in control schools to complete a CTE concentration ($p < 0.001$; Exhibit 13).

At the school level, the study team examined moderating effects of urbanicity. Among schools in rural locales, after controlling for student and school level characteristics, English I scores were significantly lower than that of schools from non-rural schools (p < 0,001; Exhibit 13). No other significant differences in outcomes were found between rural and non-rural schools.

Exhibit 13. Student- and School-Level Contrasts That Reached Statistical Significance

		Comparison group				Treatment group							
		Sample size				Sample size							
Outcome	Subgroup	# of clusters	# of students	Mean	SD	# of clusters	# of students	Mean	SD	Estimate	SE	Z-stat	*p*-value
Student-level characteristics													
Algebra II pass	Indigenous	3	8	1.00	0.00	3	164	0.83	0.38	0.12	0.05	2.70	0.01
Persistence	Indigenous	12	269	0.87	0.33	11	357	0.92	0.27	0.10	0.04	2.84	<.001
Persistence	Asian	7	43	0.88	0.32	6	35	0.80	0.41	0.08	0.03	2.53	0.01
Completing CTE concentration	Asian	6	42	0.45	0.50	3	11	0.27	0.47	0.33	0.12	2.84	<.001
Completing CTE concentration	Black	7	233	0.30	0.46	7	58	0.29	0.46	0.26	0.08	3.33	<.001

Outcome	Subgroup	Comparison group				Treatment group				Estimate	SE	Z-stat	p-value
		Sample size		Mean	SD	Sample size		Mean	SD				
		# of clusters	# of students			# of clusters	# of students						
School-level characteristics													
English I scale score	Rural school	4	202	3928	498	6	2304	3963	401	-671	175	-3.85	<.001

Note. CTE = career and technical education. Due to difficulties with model convergence, the study team dropped school-level aggregates of student gender, race/ethnicity, baseline math and reading achievement. The study team created the racial designation of Indigenous by combining the racial categories of American Indian/Alaska Native and Native Hawaiian/Pacific Islander.

RQ13. Is there a statistically significant relationship between fidelity of implementation and student outcomes?

The study team examined the extent to which school-level fidelity of implementation (discussed in the next section) was associated with student outcomes among LSS schools. There were no statistically significant positive associations between fidelity of implementation scores and student outcomes; however, there was one statistically significant negative association between fidelity of implementation and English I scale scores among LSS students ($p = 0.05$; see Exhibit 14).

Exhibit 14. The Relationship Between Fidelity of Implementation and Student Outcomes

Outcome	Estimate	SE	Z-stat	*p*-value
Algebra I scale score	48.20	102.00	0.47	0.64
Algebra II pass	0.01	0.01	1.05	0.30
English I scale score	–84.40	42.50	–1.99	0.05*
English II scale score	–74.40	92.20	–0.81	0.42
Persistence	0.00	0.01	–0.58	0.57
On track	0.02	0.02	0.67	0.51
Total dual credit hours	1.12	4.70	0.24	0.81
STEM dual credit hours	–1.04	2.00	–0.52	0.60
TSI Math	–0.06	0.10	–0.66	0.51
TSI Reading	–0.11	0.07	–1.52	0.13

Outcome	Estimate	SE	Z-stat	*p*-value
Completing CTE concentration	–0.06	0.04	–1.41	0.16

Note. SE = Standard Error; TSI = Texas Success Initiative; CTE = career and technical education. This analysis controlled for student-level covariates (gender, economic disadvantage status, special education status, emergent bilingual status, race/ethnicity, baseline math and/or reading achievement), the interaction between program participation and student covariates, school-level aggregates, cohort, and the proportion of economically disadvantaged students, students receiving special education services, and emergent bilingual students.
$^{*}p = .05$.

Implementation Study

Study Description

The extent to which the LSS program was implemented as intended provides important context for understanding the impact of the program on student outcomes. In this section we articulate the implementation research questions (IRQs) of the LSS project (Exhibit 15), provide an overview of how fidelity of implementation was measured, and provide data-driven responses to each of the IRQs. We end the section with a brief discussion of other contextualizing factors related to implementation of the LSS program.

Exhibit 15. Implementation Research Questions

Implementation research questions
1. Was the LSS program implemented with fidelity by partner organizations and participation schools?
2. How did implementation of LSS vary among treatment schools?
3. What factors enabled or inhibited successful implementation of the LSS program?
4. Does implementation of LSS influence teachers' thoughts about STEM practices at their school, STEM education beliefs, knowledge and practice of STEM integration, and knowledge and practices related to STEM careers?

Note. LSS = Lone Star STEM.

Sample

The implementation analyses focus on the 15 treatment schools (nine schools from Cohort 1, six from Cohorts 2/3) that remained in the sample at the end of the intervention period. The majority of schools ($n = 8$) implemented the T-STEM CCRM, and three schools each implemented ECHS and P-TECH models. One school had both T-STEM and ECHS models. Exhibits 16 and 17 provide further details regarding the characteristics of these schools.

Exhibit 16. Demographic Characteristics of Schools in the Implementation Study

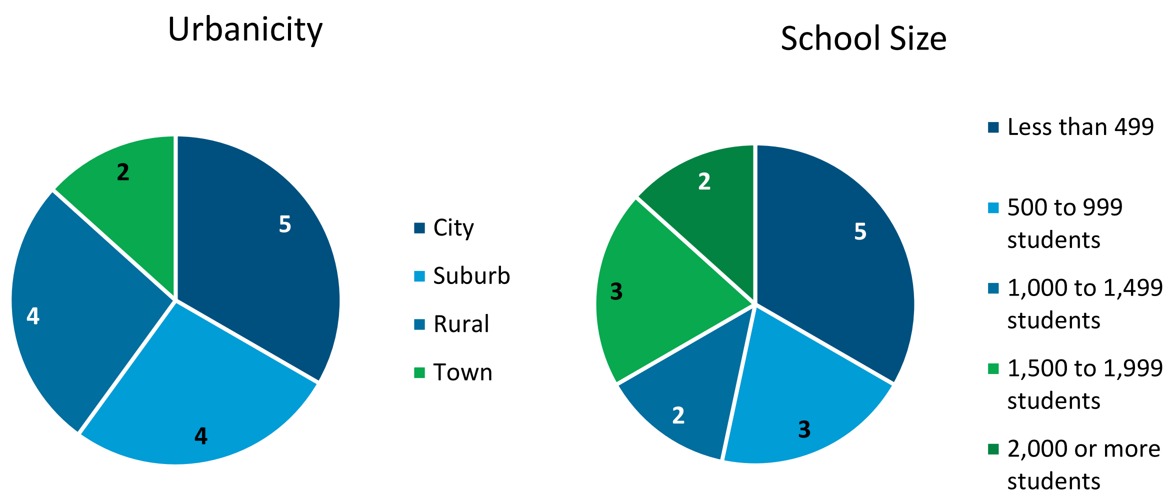
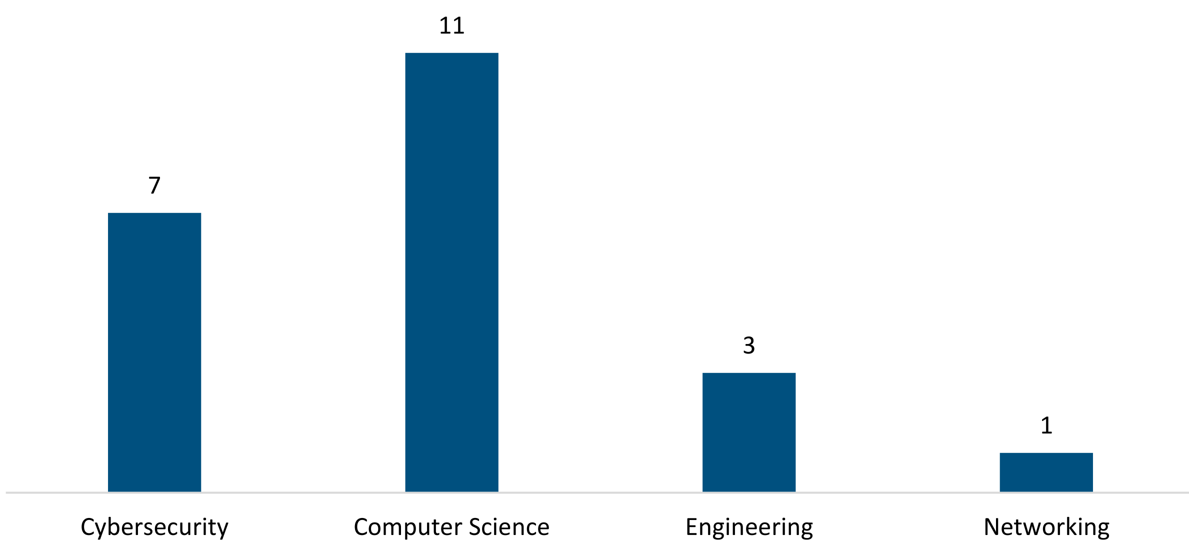


Exhibit 17. STEM Pathways Implemented by LSS Schools



Note. Categories are not mutually exclusive; five of the 15 schools implemented multiple pathways.

Data Sources

We relied on multiple data sources to answer the research questions related to LSS implementation. Exhibit 18 aligns applicable data sources with each IRQ.

Exhibit 18. Data Sources Aligned to Implementation Research Questions

Implementation Research Question	Records from JFF	Online form for Cohorts 2/3	Administrator and LSS teacher interviews	Professional development participation and certification records	ESC and TA websites	Teacher surveys
1. Was the LSS program implemented with fidelity by partner organizations and participation schools?	●	●	●	●	●	
2. How did implementation of LSS vary among treatment schools?	●	●	●	●	●	
3. What factors enabled or inhibited successful implementation of the LSS program?			●			
4. Does implementation of LSS influence teachers' thoughts about STEM practices at their school, STEM education beliefs, knowledge and practice of STEM integration, and knowledge and practices related to STEM careers?			●			●

Note. JFF = Jobs for the Future; LSS = Lone Star STEM; ESC = educational service center; TA = technical assistance.

Fidelity Measurement

Measuring the extent to which the LSS program was implemented with fidelity required alignment of key components of the logic model to measurable indicators. As more fully described in the logic model section earlier, the six key components of the LSS program were as follows:

- Component 1: Site visits/coaching calls and resources
- Component 2: Lone Star STEM resources
- Component 3: Technical assistance
- Component 4: Professional development
- Component 5: School leadership initiatives
- Component 6: Teachers' participation in professional development

For each key component, the study team worked with JFF to define indicators of adequate implementation along with units of measurement, data sources, and thresholds to indicate adequate implementation. Based on the indicators for each component, the study team identified three units of measurement: program, school, and teacher. For each of the indicators, adequate implementation was first defined at the unit of measurement and then aggregated where necessary to the larger sample level.

Data Analysis and Findings

In this section, we present fidelity of implementation findings for each of the components based on data from the sources described in Exhibit 18. Exhibit 19 presents each component's indicators and units of measurement, scoring for each indicator, possible score ranges, a definition of adequate implementation, and the final implementation score at the sample level.

Exhibit 19. Scoring That Defines Adequate Implementation of Each Key Component in the LSS Program Logic Model

Indicator	Unit of measure-ment	Indicator scoring at unit level	Indicator scoring at school level	Indicator scoring at sample level
Key Component 1: Site visits/coaching calls				
(1) One in-person site visit (2019–20) for Cohort 1 OR Coaching calls (2020–21) for Cohorts 2/3 (Planning year)	Program	1 = one in-person site visit conducted in at least 70% of Cohort 1 schools OR three coaching calls offered for Cohort 2/3 schools 0 = one in-person site visit conducted in less than 70% of schools OR fewer than three coaching calls offered for Cohort 2/3 schools		
Key Component 1 total score Site visits/coaching calls		**Sum of indicator scores at the program level** **Range 0–1**		**Adequate = 1** **Score = 1**
Key Component 2. Lone Star STEM resources				
(1) Provide Lone Star STEM resources (Years 1–3)	Program	1 = provided STEM-specific resources 0 = did not provide STEM-specific resources		
Key Component 2 total score Lone Star STEM resources		**Sum of indicator scores at the program level** **Range 0–1**		**Adequate = 1** **Score = 1**
Key Component 3. Technical assistance to build capacity				
(1) Technical assistance opportunities	Program	1 = offered two or more technical assistance opportunities		

Indicator	Unit of measure-ment	Indicator scoring at unit level	Indicator scoring at school level	Indicator scoring at sample level
(Years 1–3)		0 = offered one or less technical assistance opportunities		
(2) Coaching calls (Years 1–3)	Program	1 = offered two coaching calls 0 = Offered one or less coaching call		
(3) Peer learning network (Years 1–3)	Program	1 = offered three or more office hours sessions 0 = offered two or fewer office hours sessions		
Key Component 3 total score Technical assistance to build capacity		**Sum of indicator scores at the program level** **Range 0–3**		**Adequate = 3** **Score = 3**
Key Component 4. Professional development				
(1) STEM integration professional development (Years 1–3)	Program	1 = offered at least one workshop per year 0 = did not offer at least one workshop per year		
(2) Computer science and cybersecurity professional development (Years 1–3)	Program	1 = offered all training courses 0 = did not offer all training courses		
(3) Computer science certification workshops (Years 1–3)	Program	1 = offered at least one workshop per year 0 = did not offer at least one workshop per year		
Key Component 4 total score Professional development		**Sum of indicator scores at the program level** **Range 0–3**		**Adequate = 3** **Score = 3**
Key Component 5. School leadership initiatives				
(1) In-person site visits/coaching calls (Years 1–3)	School	1 = at least one school leadership team member participated in in-person site visit or the three virtual coaching calls 0 = no school leadership team members participated	1 = at least one school leadership team member participated in in-person site visit or the three virtual coaching calls	

Indicator	Unit of measurement	Indicator scoring at unit level	Indicator scoring at school level	Indicator scoring at sample level
		in the in-person site visit or the three virtual coaching calls	0 = no school leadership team members participated in the in-person site visit or the three virtual coaching calls	
(2) Established an open enrollment mapped pathway in computer science, cybersecurity, or engineering (Years 1–3)	School	1 = established an open enrollment mapped pathway 0 = did not establish an open enrollment mapped pathway	1 = established an open enrollment mapped pathway 0 = did not establish an open enrollment mapped pathway	
(3) Offered schoolwide STEM integration professional development (Years 1–3)	School	1 = offered four or more sessions (in person or virtual) 0 = offered three or fewer sessions (in person or virtual)	1 = offered four or more sessions (in person or virtual) 0 = offered three or fewer sessions (in person or virtual)	
(4) Established and maintained a partnership with a postsecondary institution (Years 1–3)	School	1 = established a partnership 0 = did not establish a partnership	1 = established a partnership 0 = did not establish a partnership	
(5) Established and maintained work-based learning opportunities aligned to STEM careers (authentic opportunities tied to their career pathway) with employers/ business partners (Years 1–3)	School	2 = established or maintained partnerships with two or more employer/business partners 1 = established or maintained partnership with one employer/business partner 0 = did not establish outside partnerships with employers/business partners	2 = established or maintained partnerships with two or more employer/business partners 1 = established or maintained partnership with one employer/business partner 0 = did not establish outside partnerships with employers/business partners	
Key Component 5 total score School leadership initiatives		**Sum of indicator scores at the school level** **Range 0–6**	**Adequate implementation = 5**	**Adequate = 70% of the schools with score of 5** **Score = 73%**

Indicator	Unit of measure-ment	Indicator scoring at unit level	Indicator scoring at school level	Indicator scoring at sample level
Key Component 6. Teachers' participation in professional development[a]				
(1) Computer science and cybersecurity professional development (Years 1–3)	Teacher	1 = teacher attends at least 90% of the sessions 0 = teacher attends less than 90% of the sessions		
(2) Gaining certifications in computer science and cybersecurity (Years 1–3)	Teacher	1 = teacher becomes certified/is certified 0 = teacher does not become certified		
Key Component 6 total score Teachers' participation in professional development		**Sum of the indicator score = 0–2**	**Adequate implementation = 70% of the Lone Star STEM teachers in the school with score of 1 (must have indicator 2)** **Score = 73%**	**Adequate = 70% of the schools have adequate implementation (i.e., have 70% of teachers with score of 1, must include indicator 2)** **Score = 73%**

[a] The study team removed the indicator "STEM integration professional development sessions" from Component 6 because we were not able to obtain data to address this indicator for Cohort 1 schools.

The study team used data from Exhibit 19 to answer the first implementation research question.

IRQ1. Is the LSS program implemented with fidelity by partner organizations and participation schools?

The threshold for adequate implementation for Components 1 through 4 (site visits/coaching calls, LSS resources, technical assistance, and professional development) was 100% of schools meeting the requirement, and for Components 5 and 6 (school leadership initiatives and teacher participation in professional development) it was 70% of schools. As Exhibit 20 outlines, adequate implementation was met for all six components; **100% of schools met the requirements for Components 1 through 4, and 73% of schools met the requirements for Components 5 and 6.**

Exhibit 20. Sample-Level Fidelity of Implementation Findings

	Component					
	1	2	3	4	5	6
Threshold for percentage of schools meeting the requirement for adequate implementation	100%	100%	100%	100%	70%	70%
Percentage of schools meeting requirement	100%	100%	100%	100%	73%	73%
Adequate implementation threshold met	Yes	Yes	Yes	Yes	Yes	Yes

Variation Among Treatment Schools

IRQ2. How did implementation of LSS vary among treatment schools?

To answer this question, we calculated an overall fidelity score for each school that remained in the treatment sample. As shown in Exhibit 21, we found that **variation existed between schools within the indicators comprising Components 5 and 6.** Component 5 was related to school leadership initiatives, the indicators of which were measured at the school level; Component 6 was related to teachers' participation in professional development and was measured at the teacher level.

Exhibit 21. Fidelity of Implementation Scores by Treatment School

Cohort	School	Component						Total fidelity score
		1	2	3	4	5	6	
1	Snyder Junior and High School	1	1	3	3	5	1	14
1	Fruitvale High School	1	1	3	3	6	0	14
1	Vanhorn Science and Engineering Collegiate High School Engineering Collegiate	1	1	3	3	5	1	14
1	Fabens Lone Star Academy	1	1	3	3	6	1	15
1	Canutillo Lone Star Academy	1	1	3	3	5	1	14
1	Vanguard Academy	1	1	3	3	5	1	14
1	Mercedes High School	1	1	3	3	4	1	13
1	Responsive Education: The STEM Academy of Lewisville	1	1	3	3	4	0	12
1	Arlington College and Career High School	1	1	3	3	3	0	11
2	Throckmorton Collegiate High School	1	1	3	3	5	1	14
2	IDEA Public Schools—San Juan	1	1	3	3	5	0	13
3	Cigarroa High School	1	1	3	3	6	1	15

Cohort	School	Component						Total fidelity score
		1	2	3	4	5	6	
3	Victoria West High School	1	1	3	3	5	1	14
3	C. E. King High School	1	1	3	3	6	1	15
3	Southwest High School	1	1	3	3	4	1	13

Implementation Successes and Challenges

IRQ3. What factors enabled or inhibited successful implementation of the LSS program?

To help provide important contextual information surrounding the LSS project, AIR conducted interviews with administrators and project leads from each treatment school each year of the grant period. During the implementation year of the grant, 16 administrators and project leads were interviewed from Cohort 1 and nine were interviewed from Cohorts 2/3. Student focus groups were also held during the implementation year at two Cohort 1 campuses and three Cohort 2/3 campuses. Interviewees were asked to share their perceptions of the implementation of the LSS program in their school. One section of the interview protocol asked about the factors that enabled and inhibited successful implementation of the program. **We found numerous facilitators of and challenges to implementation.** Exhibit 22 displays the main themes that reoccurred for interviewees.

Exhibit 22. Facilitators and Challenges Related to LSS Program Implementation

Facilitator	Challenge
JFF and TEA program supports	Industry partner recruitment
Teacher commitment	Teacher recruitment
Professional development	COVID-19 pandemic
Industry/employer partners	Equipment and infrastructure
Student engagement	

Note. JFF = Jobs for the Future; TEA = Texas Education Agency..

Factors That Facilitated Implementation

JFF and TEA program supports. When asked about the successes of their implementation year, main contacts and administrators noted that one factor that really helped was the continued support from JFF and TEA. Several interviewees commented that the support provided via the project webinars helped them obtain timely information and stay on track, given the other demands during their challenging school year.

> *"The planning and assistance from the grant helped us create a solid pathway."*
>
> *–District administrator interview participant*

Teacher commitment. Multiple administrators shared that their teachers had shown great flexibility and commitment while implementing the LSS Academy during the school year, especially while navigating the lingering effects of the COVID-19 pandemic. Interviewees felt that their school had continued to follow the grant guidelines because their staff remained focused on students' learning experiences.

Professional development. The project lead and administrators also mentioned being able to participate in professional development at the regional education service centers as a successful aspect of their implementation year. One Cohort 2 principal stated, "We've also participated in project-based learning and STEM training through our local service center here." Several interviewees from both cohorts shared that their LSS teachers had professional development opportunities throughout the summer with UTeach at the University of Texas.

Industry/employer partners. As part of the program, schools were expected to maintain and/or develop relationships with local businesses, employers, or industry representatives. These business partners were to collaborate with the schools to offer expanded learning experiences for students. Administrators from both cohorts reported that they had working relationships with several business and industry partners, including such companies as NASA, Cisco, Microsoft, Tesla, and Prudential. These partners allowed students to get exposure to STEM careers and have some hands-on experience in their fields of interest.

> *"I was struggling to get my game to work. I had to rework the code, but it was great to see it all come together. My game worked!"*
>
> *–Student focus group participant*

Student engagement. Another area of success that student interviewees shared was around student engagement. Across several campuses, students talked about the freedom and creativity they were given to develop their own projects. Students cited multiple hands-on projects such as app and game development, 3D printing, and coding that made their classes interesting. Several students said they enjoyed the course despite the challenging nature of the assignments. They reported that the assignments required trial and error and focus but that finishing a project was rewarding.

Challenges to Successful Implementation

Industry partner recruitment. Interviewees were asked to share the aspects of the implementation process they found most challenging. Several interviewees shared how the pandemic had hindered their plans to reach out and interact with additional industry partners in their community. A few interviewees suggested that TEA could provide support in this area by developing a list of potential employer partners.

Teacher recruitment. Another challenge that was mentioned by a few district representatives was the lack or limited number of staff. One principal shared that his campus was small, so determining which teacher(s) would teach as a part of their selected pathway was a difficult process. A few interviewees noted that being in a rural community limited their ability to keep CS teachers to their campuses. One principal explained, "We can train them to be computer science teachers, but they leave and make more money elsewhere. We can't keep them."

"We can train them to be computer science teachers, but they leave and make more money elsewhere. We can't keep them."

–Principal interview participant

COVID-19 pandemic. In general, the pandemic impacted LSS implementation in various ways. Interviewees shared that initial plans for in-person professional development for teachers were cancelled, were delayed, or became virtual activities. The pandemic interrupted the routine plans for instruction. Therefore, teachers had to split their focus between implementing the program and helping students adjust to e-learning platforms. For students, work-based opportunities were cancelled and industry representatives shared career information via virtual platforms during the start of the pandemic.

Equipment and infrastructure. A few students mentioned that their computers needed more speed and memory to handle the kinds of projects they were doing or that they wanted to do in class. A few students said they had experienced a computer crash while working on a project or that they needed better internet service.

Influence of LSS Program on Teachers' Perceptions of STEM

IRQ4. Does implementation of LSS influence teachers' thoughts about STEM practices at their school, STEM education beliefs, knowledge and practice of STEM integration, and knowledge and practices related to STEM careers?

Based on the results from teacher surveys collected among all treatment and control schools in their implementation and continuation years, we concluded that, **yes, LSS influenced teachers' perceptions to some extent.** Teachers' perceptions of STEM in their school—specifically regarding the four domains of STEM school context, STEM educational beliefs, STEM integration, and real-world STEM—were stable across all cohorts. During the 2021–22 school year, Cohort 1 treatment schools were in their continuing year, and Cohort 2/3 treatment schools were in their implementation year. During the 2022–23 school year, Cohort 1 treatment schools had cycled out of funding for the project and were no longer participating in the program, and Cohort 2/3 treatment schools were in their continuation year. Because scores can range from 1.0 (*strongly disagree*) to 4.0 (*strongly agree*), scores of 3 or higher for the four domains can be interpreted as generally positive responses, on average.

As reflected in Exhibit 23, in fall 2021, teachers in treatment schools in Cohort 1 (continuation phase) had significantly higher scores than those in control schools, on average, in the domains of STEM educational beliefs and real-world STEM. Scores went up on all scales for Cohorts 2/3 between spring 2022 (implementation phase) and spring 2023 (continuation phase) for treatments schools and down for control schools with the exception of real-world STEM. Though no other significant differences were observed between treatment and control schools in any year for either Cohort 1 or Cohorts 2/3, on the whole, scale domain scores indicate that teachers in treatment school felt more positive about STEM curriculum in their school.

Exhibit 23. Teacher Survey Domain Scores Across Time

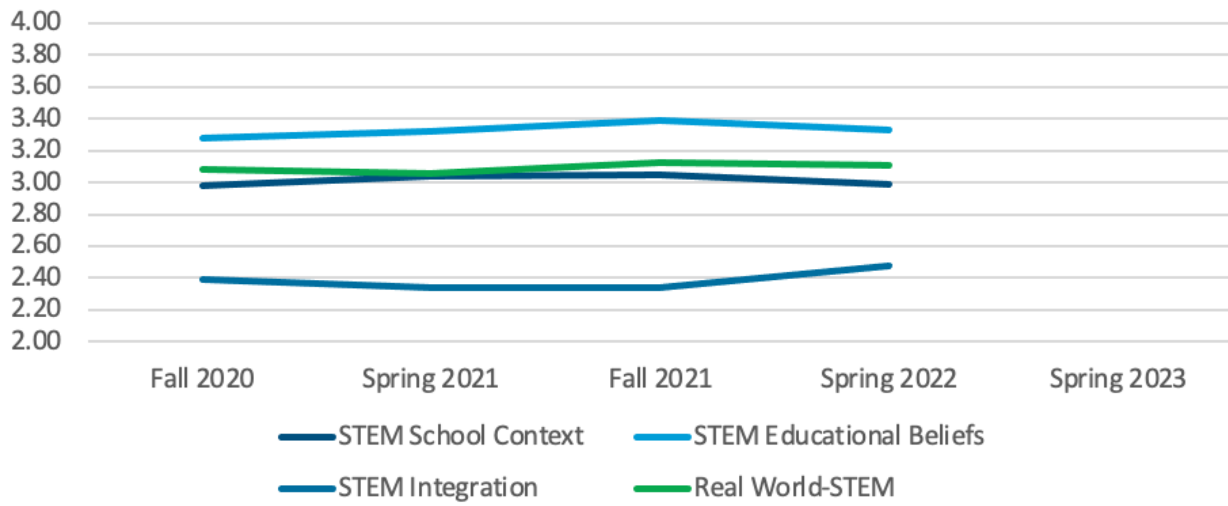
Domain	Fall 2021		Spring 2022		Spring 2023	
	Treatment	Control	Treatment	Control	Treatment	Control
Cohort 1						
STEM school context	3.05	3.01	2.99	2.96	NA	NA
STEM educational beliefs	3.39*	3.26	3.33	3.31	NA	NA
STEM integration	2.34	2.32	2.48	2.36	NA	NA
Real-world STEM	3.12*	2.98	3.11	3.07	NA	NA
Cohorts 2/3						
STEM school context	3.00	3.17	3.00	3.14	3.07	3.08
STEM educational beliefs	3.32	3.28	3.29	3.52	3.49	3.39
STEM integration	2.30	2.42	2.21	2.61	2.47	2.55
Real-world STEM	2.97	3.07	2.97	3.04	3.09	3.11

*$p < 0.05$.

Exhibits 24 and 25 show domain averages over time between fall 2021 and spring 2023 for teachers in treatment schools in Cohort 1 (Exhibit 24) and in Cohorts 2/3 (Exhibit 25). For each cohort, teachers' perceptions of the STEM school context, STEM educational beliefs, and real-world STEM remained stable and generally positive, on average. Teachers in treatment schools reported less positive perceptions regarding STEM integration in response to the survey questions, which asked specifically about teaching engineering, STEM-integrated thinking, and instructional coaching in STEM instruction.

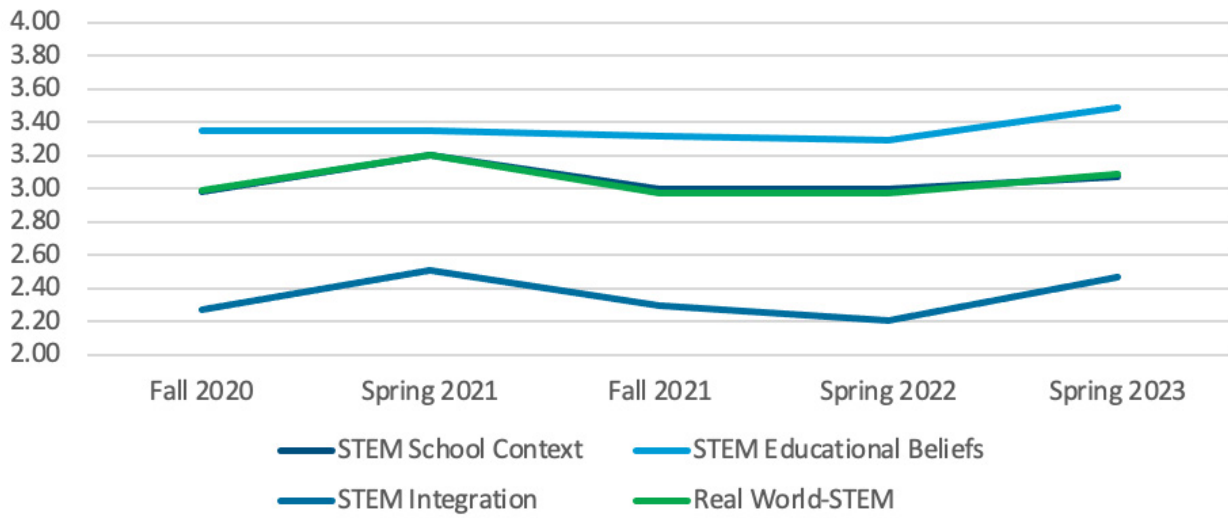
For the Cohort 1 treatment group, domain scores on STEM school context, STEM educational beliefs, and real-world STEM remained stable and positive, on average. STEM integration was the lowest scoring domain, with a small increase in score between fall 2021 and spring 2022. Teacher surveys were not collected for Cohort 1 in spring 2023 because these schools had cycled out of the LSS program.

Exhibit 24. Cohort 1 Treatment Group Teacher Survey Domain Scores Across Time



For the Cohort 2/3 treatment group, domain scores on STEM school context, STEM educational beliefs, and real-world STEM remained stable and positive, on average. Similar to Cohort 1 outcomes, STEM integration was the lowest scoring domain, with a continual decline in domain score through spring 2022 and an increase in spring 2023.

Exhibit 25. Cohort 2/3 Treatment Group Teacher Survey Domain Scores Across Time



Scale-up Evaluation Study

In this section, we identify the goals for bringing the LSS program to scale and the associated challenges to doing so. We also highlight the strategies that the LSS program employed to address each challenge. We then define the measurement for implementation of scaling strategies, as well as the threshold for successful implementation, and determine whether that threshold was met.

Strategy to Scale

The overall strategy to bring the LSS project to scale includes defining the long-term scale-up goals, identifying the challenges to meeting these goals, and describing strategies to address each challenge. Given that Texas is characterized by a large population and geography, the LSS project was an opportunity to generate lessons learned about how well elements of the LSS intervention are replicable and adaptable to other locales nationwide. As such, two of the long-term scale-up goals were as follows:

- Codify and disseminate information and strategies with the overall goal of helping education systems in CCRSMs, states, and regions implement key elements of CCRMs in STEM and overcome common implementation challenges.
- Make Texas a model for innovative and equitable solutions that can achieve nationwide scale and impact.

The identified challenges to meeting these goals were: a shortage of qualified STEM teachers, especially in CS; limited access to STEM advanced coursework and dual enrollment in rural regions; and inadequate district/school capacity to design and implement STEM and CS dual enrollment pathways aligned to labor-market needs. In order to address these challenges, JFF and partners took the following actions:

- Convened an LSS school peer learning network, which surfaced common challenges and best practices. JFF and project partners documented these challenges and successes in publications such as case studies, policy briefs, reports, and blogs.
- JFF researched and created externally available program-of-study maps, competency maps, and credential maps in CS and cybersecurity to provide a clear framework for designing dual enrollment pathways that were aligned with regional labor markets and culminated in industry-recognized credentials.
- Project partners also presented on LSS at national conferences with similar focus areas (e.g., STEM, CS, dual enrollment, early college, career pathways, CTE) and held LSS webinars open to a national audience.
- TEA's CCRSM blueprints, which described inputs and outputs necessary to create high-quality dual enrollment pathways in STEM-specific areas, are also clear and powerful roadmaps for other states.

Exhibit 26 outlines the scale-up goals, challenges to meeting the goals, and strategies to address the challenges.

Exhibit 26. Elements of the Scale-Up Approach to the LSS Program

Scale-up goal	Challenge to meeting goal	Strategy to address challenge
Increase the number of districts with at least one teacher who is certified to teach CS and cybersecurity in Texas.	Shortage of teachers qualified to teach in STEM, especially in CS	Offer professional development courses each year in teaching CS and cybersecurity for teachers in participating LSS schools.
Conduct training in how to implement dual enrollment pathways. Work with districts and schools to develop partnerships with secondary education partners and local employers.	Inadequate district and school capacity to develop dual enrollment career pathways in high schools	Collaborate with key state employers and TEA to support schools to develop dual enrollment career pathways aligned with employer-validated competencies and industry-recognized credentials with labor market value.
Develop tools and resources for designing dual enrollment pathways. Create an online portal for accessing resources and a peer network. Update T-STEM Blueprint to incorporate LSS program requirements and activities.	Lack of resources to support replication	Create an externally available program of tools and resources to provide a clear framework for designing dual enrollment pathways aligned with regional labor markets and industry-recognized credentials: • Create an LSS school peer learning network. • Disseminate best practices for replication via the JFF national Pathways to Prosperity Network. • Update T-STEM Blueprint to incorporate LSS program requirements and activities.

Note. CS = computer science; T-STEM = Texas Science Technology Engineering Mathematics; LSS = Lone Star STEM; TEA = Texas Education Agency.

Measurement of Implementation of Scaling Strategies

Exhibit 27 provides additional details regarding the way full implementation of the strategy is defined, the threshold for successful implementation, and the data collection and reporting plan for measuring the implementation of each strategy.

Exhibit 27. Measurement of Scaling Strategies for the LSS Program

Scale-up goal	Challenge to meeting goal	Strategy to address challenge	Definition of "full implementation of the strategy" (in measurable units)	Threshold for level of implementation defined as "successful"	Data collection and reporting plan for measuring implementation of the strategy
Increase the number of districts with at least one teacher who is certified to teach CS or cybersecurity in Texas.	Shortage of teachers qualified to teach in STEM, especially in CS and cybersecurity	Offer professional development courses each year in teaching CS and cybersecurity for teachers in participating LSS schools.	25 school districts with at least one teacher certified to teach CS or cybersecurity	20 school districts with at least one teacher certified to teach CS or cybersecurity	Teacher certifications obtained from TEA/JFF Reporting: summer 2023
Conduct training in ways to implement dual enrollment pathways.	Inadequate district and school capacity to develop dual enrollment career pathways in high schools	Collaborate with key state employers and TEA to support schools to develop dual enrollment career pathways aligned to employer-validated competencies and industry-recognized credentials with labor market value.	Each LSS school develops at least one postsecondary education partner	85% of LSS schools establish partnerships with at least one postsecondary education partner per school	Interviews with grantees
Work with districts and schools to develop partnerships with postsecondary education partners and local employers.			Each LSS school offers least one dual enrollment career pathway	85% of LSS schools offer at least one dual enrollment career pathway	Reporting: spring 2023

Scale-up goal	Challenge to meeting goal	Strategy to address challenge	Definition of "full implementation of the strategy" (in measurable units)	Threshold for level of implementation defined as "successful"	Data collection and reporting plan for measuring implementation of the strategy
Develop tools and resources for designing dual enrollment pathways.	Lack of resources to support replication	Create an externally available program of tools and resources to provide a clear framework for designing dual enrollment pathways aligned with regional labor markets and industry-recognized credentials.	Development of at least three tools and resources for designing dual enrollment pathways	Development of at least two tools and resources for designing dual enrollment pathways	Tools and resources collected from TEA/JFF
Create an online portal for accessing resources and peer network.		• Create an LSS school peer-learning network. • Disseminate best practices for replication via the JFF national Pathways to Prosperity Network.	Development of an online portal for accessing resources and peer network	Development of an online portal for accessing resources and peer network	• Access to online portal from TEA/JFF • Updated T-STEM Blueprint collected from TEA
Update T-STEM Blueprint to incorporate LSS program requirements and activities.		Update T-STEM Blueprint to incorporate LSS program requirements and activities.	Updated T-STEM Blueprint	Updated T-STEM Blueprint	Reporting: summer 2023

Note. T-STEM = Texas Science Technology Engineering Mathematics; LSS = Lone Star STEM; CS = computer science; TEA = Texas Education Agency; JFF = Jobs for the Future.

Findings on Implementation of Scaling Strategies

Exhibit 28 depicts each scale-up strategy, the threshold for successful implementation, findings on actual level of implementation, and a determination on whether the threshold was met. As shown, **the LSS program met the threshold for successful implementation on all scale-up strategies.**

Exhibit 28. Overall Findings on Implementation of Scale-Up Strategies for the LSS Program

Scale-up strategy	Threshold for successful implementation	Findings on actual level of implementation	Implementation of strategy met or exceeded threshold (yes/no)
Offer professional development courses each year in teaching CS and cybersecurity for teachers in participating LSS schools.	20 school districts have at least one teacher certified to teach CS or cybersecurity.	79 school districts have at least one teacher certified to teach CS or cybersecurity.	Yes
Collaborate with key state employers and TEA to support schools to develop dual enrollment career pathways aligned with employer-validated competencies and industry-recognized credentials with labor market value.	85% of LSS schools establish partnerships with at least one postsecondary education partner.	100% of LSS schools establish at least one postsecondary education partner.	Yes
	85% of LSS schools offer at least one dual enrollment career pathway.	100% of LSS schools offer at least one dual enrollment career pathway.	Yes
Create externally available program of tools and resources to provide a clear framework for designing dual enrollment pathways aligned with regional labor markets and industry-recognized credentials. • Create an LSS school peer learning network. • Disseminate best practices for replication via the JFF national Pathways to Prosperity Network. • Update T-STEM Blueprint to incorporate LSS program requirements and activities.	Development of at least two tools and resources for designing dual enrollment pathways.	• Scaling Dual Enrollment in Rural Communities • Framework for the Design and Implementation of College in Career Pathways in Rural Communities	Yes
	Development of an online portal for accessing resources and peer network.	Canvas modules	Yes
	Updated T-STEM Blueprint.	TEA T-STEM Blueprint	Yes

Note. CS = computer science; LSS = Lone Star STEM; TEA = Texas Education Agency; JFF = Jobs for the Future; T-STEM = Texas Science Technology Engineering Mathematics.

Cost-Effectiveness Study

To determine the cost-effectiveness of implementing LSS, AIR calculated the per-pupil annual expenditure, excluding the cost of the evaluation and management of the grant, using data provided by JFF. The per-pupil cost included all funds provided to districts to implement the LSS program in their schools during the planning, implementation, and continuation years. The per-pupil cost also included the cost of all professional development and resources provided.

Cost per Student

The evaluation team considered (a) the total cost to develop and implement the LSS program and (b) the cost of implementation only because future adopters of the LSS program will likely be interested in the cost associated with implementation given that resources aligned with the LSS program have already been developed. According to expenditure data from Years 1–5 provided by JFF, the total cost to develop and implement the LSS program was $5,186,581. The total cost to implement the program in Years 3–5, the period of time in which students in the treatment schools were exposed to the LSS program, was $4,306,569. The total number of students served by the LSS program across all applicable schools aligns with the analytic sample (*n* = 3,584).

Exhibit 29 provides the cost per student in dollars for each of the 5 years of the program as well as notes on the costs included in the calculation.

Exhibit 29. Per Student Cost, by Year for the LSS Program

Year	Cost per student	Notes on costs included in cost per student
1	$59	$212,563 expenditure/3,584 Cohort 1 and Cohort 2/3 students
2	$187	$668,449 expenditure/3,584 Cohort 1 and Cohort 2/3 students
3	$488	$1,748,857 expenditure/3,584 Cohort 1 and Cohort 2/3 students
4	$402	$1,441,739 expenditure/3,584 Cohort 1 and Cohort 2/3 students
5	$311	$1,114,973 expenditure/3,584 Cohort 1 and Cohort 2/3 students

Note. Expenditures do not include costs associated with evaluation services or management of the grant. The student sample is based on the analytic treatment sample.

On the basis of these calculations, **the total cost per student to develop and implement the LSS program was $1,447, whereas the total cost per student to implement was $1,201.**[1]

[1] Because there are no significant pooled average causal effects on the full sample, it is not appropriate to employ a cost-effectiveness ratio calculation. Although there are a handful of significant subgroup effects (as outlined in Exhibit 29), it is not appropriate to calculate a cost-effectiveness ratio for these groups unless the services they were provided as part of the LSS program were substantially different from what other participants received or if they clustered in specific schools, which was not the case.

Discussion

The LSS program was designed to increase STEM educational opportunities for traditionally underrepresented groups, with an ultimate goal of increasing innovation and creativity in the STEM field through a diversity of backgrounds and lived experiences, promoting equity, and growing the pool of qualified STEM workers.

The LSS program was helpful for some student groups

AIR examined the impact of the LSS program on students' academic achievement, persistence toward graduation, and college and career readiness. Although the analysis did not uncover any main effects on student outcomes, we see significant moderating effects on the likelihood of passing Algebra II, persistence toward graduation, and the likelihood of completing a CTE concentration among specific racial groups. Specifically, two underrepresented racial groups, Indigenous students and Black students, saw significant gains in outcomes related to academic achievement, staying on track to graduation, and career readiness. These findings are promising because Indigenous and Black people are underrepresented as STEM undergraduates, graduates, and part of the STEM workforce (National Center for Science and Engineering Statistics, 2023). At the school level, we saw that nonrural schools had significantly higher English I scores than rural schools, which may be related to rural schools' challenges with recruiting and retaining highly qualified teachers.

Although fidelity of implementation had little association with student outcomes, it is important to keep in mind that schools in the treatment group met the threshold for adequate implementation for all six indicators. So it is possible that there was not enough variability in implementation among the schools to see differences in student outcomes.

All six components of the LSS program met the criteria for adequate implementation despite the major disruption of school closures to prevent the spread of COVID-19 in spring 2020. Although COVID-19 was elevated as a challenge to implementation, at the program level, LSS was able to implement the program 100% as intended by pivoting from in-person site visits to virtual coaching calls with school leadership. Two main themes arose across the LSS implementation study: (1) supports and buy-in as clear facilitators and (2) COVID-19 and locale being the barriers to successful implementation.

The success of the LSS program was facilitated by reliable supports and participant buy-in

During interviews and focus groups throughout the grant period, administrators, staff, and students all shared their perceptions of what made the LSS program successful. The resources provided by JFF and TEA, such as timely communication and planning assistance, as well as the professional development opportunities available to teachers through the University of Texas at Austin all helped ensure schools had what they needed to implement the program as intended. Administrators also discussed the strong positive relationships they were able to develop with business and industry partners that exposed their students to STEM careers with hands-on experiences, which notably was more of a success for schools in Cohort 1, which began the LSS program before the pandemic. With such strong resources, support, and partnerships, it comes as no surprise that participants at all levels felt a strong sense of commitment to the program. Administrators credited their staff's commitment to students' learning for their ability to continue following grant guidelines, even in the wake of the pandemic and the upheaval it brought to schools. Student engagement also facilitated the LSS program's success; students were excited by the projects they were involved in, highlighting overcoming struggles and celebrating wins. Taken together, supportive, communicative, and resourceful program staff allowed administrators the space to provide support to teachers, who in turn mirrored this commitment and support with teaching and student learning.

When implementation was hindered, COVID-19 and locale played a large role

Variation in implementation surfaced with the school- and teacher-level components. Schools struggled with two specific indicators of adequate implementation for the school leadership initiatives component. First, four schools did not meet the threshold for adequate implementation for offering schoolwide STEM integration professional development (i.e., offering four or more in-person or virtual sessions). This is further evidenced by the fact that, according to the annual teacher surveys, scores on the domain of STEM integration (including items such as "*I am confident that I can teach STEM integrated thinking effectively"* and "*I have received professional development that has prepared me to teach STEM integrated thinking*") were consistently lower than on the other three domains across all reporting periods. Second, many schools struggled to establish and maintain authentic work-based opportunities tied to career pathways. Schools were expected to establish and maintain partnerships with two or more employers; however, eight of the 15 schools in the implementation analysis were able to establish only one partnership, and two schools were not able to establish any partnerships. The COVID-19 pandemic was cited by interviewees as a challenge, particularly among Cohort 2/3, which started the LSS program in the first full school year after the pandemic shut down many in-person work opportunities, which was a barrier to accomplishing both of these initiatives. Professional development sessions were cancelled due to the upheaval of adjusting to e-learning platforms, and interaction with industry partners became increasingly difficult, with work-based opportunities for students getting canceled as learning became virtual.

Additionally, some schools struggled with teachers' participation in professional development. In particular, teachers from the four schools that struggled with offering STEM integration professional development did not complete cybersecurity or computer science certifications. This may in part be explained by participating schools in rural areas that struggled to recruit and retain computer science teachers and identify which teachers from their very small campuses would do the teaching/certification for their selected pathway.

LSS scale-up strategies have potential to strengthen STEM in rural communities

The LSS program was successful in its scale-up goals, resulting in statewide updated blueprints for STEM dual credit pathways that align with local labor markets. Not only did LSS create a framework for increasing STEM dual credit pathways in rural communities, but it documented the process of implementing that framework in a case study of three LSS grantees in rural areas. Additionally, LSS far exceeded the goal to increase the number of school districts that have at least one certified teacher. According to LSS partners at the University of Texas at Austin, at the conclusion of the grant 79 districts had at least one teacher with a credential in these areas. One major barrier to implementation of LSS was among rural districts, where administrators found it hard to recruit and retain teachers for these courses. The framework provided by LSS lays out several strategies for mitigating those barriers, especially for rural districts, including leveraging remote project-based learning, aligning the pathways with local labor markets and industry, leveraging the knowledge and skills of existing district staff, and fostering partnerships with multiple colleges and businesses.

Conclusions and Recommendations

There are several main takeaways from the LSS study. The program was effective for some specific student groups who have traditionally been underrepresented in STEM, Indigenous and Black students, in the areas of academic achievement, remaining on track to graduate, and career readiness. Program effectiveness varied among rural versus nonrural schools only for English I scores. Additionally, all schools met the threshold for adequate implementation, but further examination of the facilitators and barriers associated with successful implementation uncovered rural schools' struggle to recruit and retain qualified computer science teachers. Future programs should consider more nuanced ways in which to measure fidelity in order to capture more variation in implementation fidelity, allowing developers to course correct on an ongoing basis for schools experiencing challenges.

The scale-up framework for implementing STEM dual credit in rural communities provides several practical, feasible strategies for rural schools interested in implementing STEM dual credit pathways. LSS published a case study documenting the implementation of this framework in three rural communities (Burton et al., 2023), with strategies to overcome distance to higher education and industry partners, providing support for students pursuing college coursework and navigating the college going process, and increasing the capacity of existing staff to implement dual credit coursework. Given many rural schools' difficulty with implementation of the LSS program, this framework can provide a roadmap to help overcome many of the barriers to STEM dual credit implementation that are unique to rural communities. Further, the framework itself is worthy of further study given the success the schools had in implementing some of the strategies documented in the case study.

One final consideration for future programs relates to the accessibility of grant funding for participating schools. Schools participating in the LSS program were required to reapply for funding each year, so schools needed to be proactive each year of the grant to continue to receive funding. Although COVID-19 contributed to barriers to implementation with schools going remote, during the grant period there was also an influx of millions of federal relief dollars to states aimed at helping schools and districts recover from the effects of the pandemic. These funds were plentiful and easier to attain, with little accountability tied to their use. This alternative source of funding and the initiatives this money paid for may have taken precedent in a time of states, districts, and schools trying to address lost learning time and may have overshadowed LSS efforts to improve access to STEM dual credit coursework. State agencies and other program developers interested in implementing and evaluating programs like LSS in the future should consider streamlining the funding mechanisms for participating schools.

Appendix A

During summer 2019, the American Institutes for Research® (AIR®) worked with the Texas Education Agency (TEA) to develop a process for selecting schools to participate in Lone Star STEM (LSS) programming and to be randomly assigned to treatment or control conditions. AIR's evaluation of the LSS program used cluster-level random assignment, in which schools were randomly assigned to treatment or control conditions within blocks.

The original design for the evaluation specified that two cohorts of 30 schools—15 treatment and 15 control schools—would participate in the evaluation, for a total of 60 schools. In fall 2019, more than 30 schools applied to participate in the LSS program, thereby requiring AIR to work with TEA to develop a process to narrow down the pool of applicants to 30 schools. In summer 2020, however, because of the COVID-19 pandemic, fewer schools applied to participate in Cohort 2. As a result, TEA opened a third cohort of schools, which were recruited to participate in fall 2020. Within each cohort, schools were randomly assigned to treatment or control groups within blocks.

Step 1: Reducing the Number of Schools per District

All public school districts across Texas, including open-enrollment charter schools, were invited to apply to participate in the LSS program. During spring 2019 (Cohort 1), summer 2020 (Cohort 2), and fall 2020 (Cohort 3), TEA distributed a Request for Letters of Interest (RLI) by email to district superintendents, inviting them to submit applications to establish an LSS Academy. The RLI outlined the purpose of the evaluation, including procedures for randomizing schools into treatment or control conditions; the required program activities; district eligibility guidelines; and formative evaluation metrics. Applications for participation were required to be submitted by the end of the designated application period. At the end of the application period, TEA screened the applications to ensure that they met eligibility requirements.

To be eligible to participate in the LSS program, public school districts and open-enrollment charter schools were required to submit an application for a school that (a) was an autonomous school (i.e., a stand-alone campus or a smaller learning community within a larger high school), (b) served Grades 6–12 or Grades 9–12 with an active relationship with the feeder middle school(s), (c) served Grade 9 during the first year of operation, and (d) offered open enrollment, hosting lotteries for admission (if necessary because of oversubscription). Applications had to follow all requirements and indicators outlined in the RLI.[2] Special consideration and priority were given to districts that sought to develop or expand career pathways in cybersecurity and computer science as well as to districts classified as rural.

Districts were invited to submit separate applications for one or more schools; however, only one school per district could be included in the evaluation. For districts that submitted applications for more than one school, only one school was selected to be eligible to participate in the evaluation, through the following process:

- If all eligible schools in the district planned to implement computer science or cybersecurity pathways, AIR randomly selected one school from all eligible schools in the district.[3]
- If more than one eligible school in the district proposed to build cybersecurity or computer science pathways, the AIR study team omitted schools that were not planning to implement either of these pathways. AIR then (a) selected the school that planned to implement a computer science or cybersecurity pathways or (b) randomly selected one school from the remaining eligible schools that were planning to implement computer science or cybersecurity pathways.

[2] Additional eligibility requirements included (1) a public district or open-enrollment charter applying for this grant must be financially stable, as determined through fiscal review by the TEA's Division of Financial Audits; (2) a district or open-enrollment charter school must have submitted the annual financial audits to the TEA Division of Financial Audits in the time and manner required by that division; (3) an open-enrollment charter school authorized by the State Board of Education applying for this grant must request an amendment to its open-enrollment charter in order for the school to be allowed to function as an LSS Academy. The request must be submitted to the commissioner of education and must receive proper approval for the school to operate as an LSS Academy. An amendment to request approval to function as an LSS Academy that involves expanding grade levels, increasing the maximum enrollment of the charter, expanding the geographical boundaries, and/or adding a site or campus must be submitted to the Division of Charter Schools; (4) an open-enrollment charter campus shall become ineligible for grant funding (or, if a campus has applied for and received funding for this grant, will have its grant funding placed on hold) if the commissioner notifies the campus's charter holder of the commissioner's intent to (a) revoke or not renew such charter under Texas Education Code (TEC) Chapter 12 or (b) close the campus under TEC Chapter 39, for any reasons set forth in either statutory provision. If the commissioner ultimately revokes or denies renewal of an open-enrollment charter of a charter holder or closes a campus that has been awarded funds under this grant program, grant funding shall be discontinued; and (5) open-enrollment charter schools operated by a nonprofit charter holder must attach to the application a copy of the current (i.e., within the last 10 years) proof of nonprofit status for the application to be eligible for review and scoring.

[3] LSS schools may implement computer science, cybersecurity, or engineering career pathways. However, a specific focus of the LSS program is on expanding access to computer science and cybersecurity courses and credentials. Therefore, schools proposing to implement these pathways were prioritized over schools proposing to implement engineering pathways for inclusion in the evaluation.

Step 2: Identifying the Sample of Schools

As stated previously, the LSS program was able to accommodate up to a total of 60 schools—30 treatment and 30 control schools. The original plan called for two cohorts of 30 schools—15 treatment and 15 control schools. When more than 30 schools applied and met the eligibility requirements in spring 2019, the pool of eligible schools was reduced to 30 through the following process:

1. Select all eligible rural schools.
2. If fewer than 30 schools were selected in Step 1, select all eligible schools planning to implement cybersecurity or computer science pathways:
    a. If there were fewer schools than the remaining slots, select all schools planning to implement cybersecurity or computer science pathways.
    b. If there were more schools than the remaining slots, randomly select the number of schools necessary to reach the desired sample size of 30 schools from those planning to implement computer science or cybersecurity pathways.
3. If fewer than 30 schools were selected after Step 2, randomly select the number of schools necessary to reach the desired sample size of 30 schools from the pool of eligible schools that do not plan to implement computer science or cybersecurity pathways.[4]

In summer and fall 2020, fewer schools than could be accommodated applied for the grant. Therefore, all schools meeting the requirements for Step 1 were included in the program.

Step 3: Randomly Assigning Schools to Conditions

Random assignment of schools was conducted prior to each cohort's planning year—summer 2019, summer 2020, and fall 2020—for three cohorts. Schools were randomly assigned to either the treatment or the control condition through the following procedures:

- In line with a program goal of dispersing STEM coursework opportunities across Texas, schools were separated into blocks by TEA district classification (i.e., major urban, major suburban, other central city, other central city suburban, nonmetropolitan fast growing, nonmetropolitan stable, rural, charter school districts).
- Within each TEA district classification, schools were randomly assigned to treatment or control conditions.[5]

Randomization was conducted using random selection procedures in SAS.

[4] These schools intended to develop engineering pathways.
[5] TEA classifications were combined if only one school from a classification category was included in the pool of schools for random assignment.

Appendix B. Baseline Equivalence for Outcomes in the Impact Analysis

	Treatment mean (SD)	Control mean (SD)	Effect size
Algebra I scale score			
Asian	0.01	0.01	0.00
Black	0.16	0.15	0.05
Hispanic	0.78	0.85	–0.28[b]
Indigenous[a]	0.09	0.09	0.00
White	0.76	0.75	0.03
Female	0.48	0.50	–0.05
Emergent bilingual	0.25	0.09	0.74[b]
Economically disadvantaged	0.80	0.71	0.30[b]
STAAR Grade 7 or 8 Math	1561.26 (165.21)	1564.86 (137.09)	–0.02
STAAR Grade 7 or 8 Reading	1593.58 (124.88)	1618.64 (132.49)	–0.20
Algebra II pass			
Asian	0.01	0.03	–0.69[b]
Black	0.12	0.12	0.00
Hispanic	0.81	0.70	0.37[b]
Indigenous[a]	0.11	0.13	–0.12
White	0.79	0.75	0.14
Female	0.50	0.52	–0.05
Emergent bilingual	0.21	0.09	0.60[b]
Economically disadvantaged	0.76	0.71	0.16
STAAR Grade 7 or 8 Math	1567.53 (233.25)	1525.24 (309.37)	0.16
STAAR Grade 7 or 8 Reading	1650.65 (136.01)	1677.76 (180.70)	–0.18
English I scale score			
Asian	0.01	<0.01*	<0.01
Black	0.14	0.16	–0.10
Hispanic	0.79	0.83	–0.16
Indigenous[a]	0.09	0.08	0.08
White	0.78	0.75	0.10

	Treatment mean (SD)	Control mean (SD)	Effect size
Female	0.49	0.49	0.00
Emergent bilingual	0.22	0.08	0.71[b]
Economically disadvantaged	0.77	0.71	0.19
STAAR Grade 7 or 8 Math	1569.96 (194.94)	1573.99 (145.94)	–0.02
STAAR Grade 7 or 8 Reading	1619.06 (131.88)	1629.02 (130.58)	–0.08
English II scale score			
Asian	0.01	0.02	–0.43[b]
Black	0.12	0.13	–0.06
Hispanic	0.80	0.71	0.30[b]
Indigenous[a]	0.10	0.13	–0.18
White	0.79	0.75	0.14
Female	0.49	0.49	0.00
Emergent bilingual	0.22	0.12	0.44[b]
Economically disadvantaged	0.77	0.73	0.13
STAAR Grade 7 or 8 Math	1569.08 (223.60)	1549.25 (284.95)	0.08
STAAR Grade 7 or 8 Reading	1643.79 (131.71)	1687.50 (123.59)	–0.34[b]
On track			
Asian	0.01	0.02	–0.43[b]
Black	0.12	0.14	–0.11
Hispanic	0.80	0.68	0.38[b]
Indigenous[a]	0.10	0.13	–0.18
White	0.79	0.74	0.17
Female	0.49	0.49	0.00
Emergent bilingual	0.21	0.12	0.40[b]
Economically disadvantaged	0.77	0.73	0.13
STAAR Grade 7 or 8 Math	1564.34 (220.03)	1554.78 (285.93)	0.04
STAAR Grade 7 or 8 Reading	1634.71 (140.96)	1661.69 (174.74)	–0.17
Persistence			
Asian	0.01	0.02	–0.43[b]
Black	0.12	0.14	–0.11
Hispanic	0.80	0.68	0.38[b]
Indigenous[a]	0.10	0.13	–0.18

	Treatment mean (SD)	Control mean (SD)	Effect size
White	0.79	0.74	0.17
Female	0.49	0.49	0.00
Emergent bilingual	0.21	0.12	0.40[b]
Economically disadvantaged	0.77	0.73	0.13
STAAR Grade 7 or 8 Math	1564.34 (220.03)	1554.78 (285.93)	0.04
STAAR Grade 7 or 8 Reading	1634.71 (140.96)	1661.69 (174.74)	–0.17
Total dual credit hours			
Asian	0.01	0.02	–0.43[b]
Black	0.12	0.14	–0.11
Hispanic	0.80	0.68	–0.38[b]
Indigenous[a]	0.10	0.13	–0.18
White	0.80	0.74	0.21
Female	0.48	0.49	–0.02
Emergent bilingual	0.22	0.12	0.44[b]
Economically disadvantaged	0.77	0.73	0.13
STAAR Grade 7 or 8 Math	1564.34 (220.03)	1545.08 (285.53)	0.09
STAAR Grade 7 or 8 Reading	1634.77 (140.23)	1661.67 (174.61)	–0.18
STEM dual credit hours			
Asian	0.01	0.02	–0.43[b]
Black	0.12	0.14	–0.11
Hispanic	0.80	0.68	–0.38[b]
Indigenous[a]	0.10	0.13	–0.18
White	0.80	0.74	0.21
Female	0.48	0.49	–0.02
Emergent bilingual	0.22	0.12	0.44[b]
Economically disadvantaged	0.77	0.73	0.13
STAAR Grade 7 or 8 Math	1567.87 (218.60)	1545.08 (285.53)	0.09
STAAR Grade 7 or 8 Reading	1634.77 (140.23)	1661.67 (174.61)	–0.18
TSI Math			
Asian	0.02	0.04	–0.43[b]
Black	0.10	0.09	0.07
Hispanic	0.77	0.71	0.19

	Treatment mean (SD)	Control mean (SD)	Effect size
Indigenous[a]	0.12	0.13	–0.06
White	0.78	0.77	0.03
Female	0.53	0.58	–0.12
Emergent bilingual	0.12	0.04	0.72[b]
Economically disadvantaged	0.73	0.66	0.20
STAAR Grade 7 or 8 Math	1550.68 (287.78)	1459.64 (335.30)	0.30[b]
STAAR Grade 7 or 8 Reading	1709.64 (134.76)	1686.20 (217.68)	0.14
TSI Reading			
Asian	0.02	0.04	–0.43[b]
Black	0.10	0.09	0.07
Hispanic	0.77	0.71	0.19
Indigenous[a]	0.12	0.13	–0.06
White	0.78	0.77	0.03
Female	0.53	0.58	–0.12
Emergent bilingual	0.12	0.04	0.72[b]
Economically disadvantaged	0.73	0.66	0.20
STAAR Grade 7 or 8 Math	1550.68 (287.78)	1459.64 (335.30)	0.30[b]
STAAR Grade 7 or 8 Reading	1709.64 (134.76)	1686.20 (217.68)	0.14
Completing CTE concentration			
Asian	0.01	0.02	–0.43[b]
Black	0.05	0.13	–0.63[b]
Hispanic	0.84	0.66	0.60[b]
Indigenous[a]	0.13	0.14	–0.05
White	0.82	0.74	0.29
Female	0.47	0.48	–0.02
Emergent bilingual	0.22	0.13	0.39[b]
Economically disadvantaged	0.78	0.73	0.16
STAAR Grade 7 or 8 Math	1564.98 (264.83)	1542.73 (295.76)	0.08
STAAR Grade 7 or 8 Reading	1671.54 (149.49)	1665.78 (177.17)	0.04

Note. STAAR = State of Texas Assessments of Academic Readiness; SD = standard deviation; TSI = Texas Success Initiative.

[a]Combined American Indian and Hawaiian/Pacific Islander. [b]Denotes a baseline equivalence >|0.25|.

References

Bailey, M. J,. & Dynarski, S. M. (2011). Inequality in postsecondary education. In G. Duncan & R. Murnane (Eds.), *Whither opportunity?* Russell Sage Foundation.

Bureau of Labor Statistics. (2024). *Employment projections—2023–2033*. U.S. Department of Labor. https://www.bls.gov/news.release/pdf/ecopro.pdf

Burton, C., Jenness, S., Mindy, D., & O'Connor, A. (2023). *Scaling dual enrollment in rural communities. Jobs for the Future.* https://www.jff.org/idea/scaling-dual-enrollment-in-rural-communities-a-case-study-of-three-rural-texas-high-schools/

Lee, S., & Shapiro, D. (2023, November). Completing college: National and state report with longitudinal data dashboard on six- and eight-year completion rates (Signature Report 22). National Student Clearinghouse Research Center.

Mishel, L., Bivens, J., Gould, E., & Shierholz, H. (2012). *The state of working America* (12th ed.). Economic Policy Institute. https://www.epi.org/publication/getswa/

National Center for Education Statistics. (2018). *Status and trends in the education of racial and ethnic groups, indicator 26: STEM degrees.* https://nces.ed.gov/pubs2019/2019038.pdf

National Center for Science and Engineering Statistics. (2023). *Diversity and STEM: Women, minorities, and persons with disabilities 2023* (Special Report NSF 23-315). National Science Foundation. https://ncses.nsf.gov/wmpd

Oliss, B., McFaul, C., & Riddick, J. C. (2023). *The global distribution of STEM graduates: Which countries lead the way?* Center for Security and Emerging Technology. https://cset.georgetown.edu/article/the-global-distribution-of-stem-graduates-which-countries-lead-the-way/

Rothwell, J. (2013, June). *The hidden STEM economy*. Brookings Institution, Metropolitan Policy Program.

Ryan, C. L., & Bauman, K. (2016). *Educational attainment in the United States: 2015.* U.S. Census Bureau. https://www.census.gov/content/dam/Census/library/publications/2016/demo/p20-578.pdf

Smith, K., Jagesic, S., Wyatt, J., & Eqing, M. (2018). *AP STEM participation and postsecondary STEM outcomes: Focus on underrepresented minority, first-generation, and female students.* College Board. https://files.eric.ed.gov/fulltext/ED581514.pdf

U.S. Census Bureau. (2021). *2021 Annual social and economic supplement.* https://www2.census.gov/programs-surveys/cps/techdocs/cpsmar21.pdf

What Works Clearinghouse. (2022). *What Works Clearinghouse procedures and standards handbook, version 5.0*. U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance. https://ies.ed.gov/ncee/wwc/Docs/referenceresources/Final_WWC-HandbookVer5_0-0-508.pdf

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