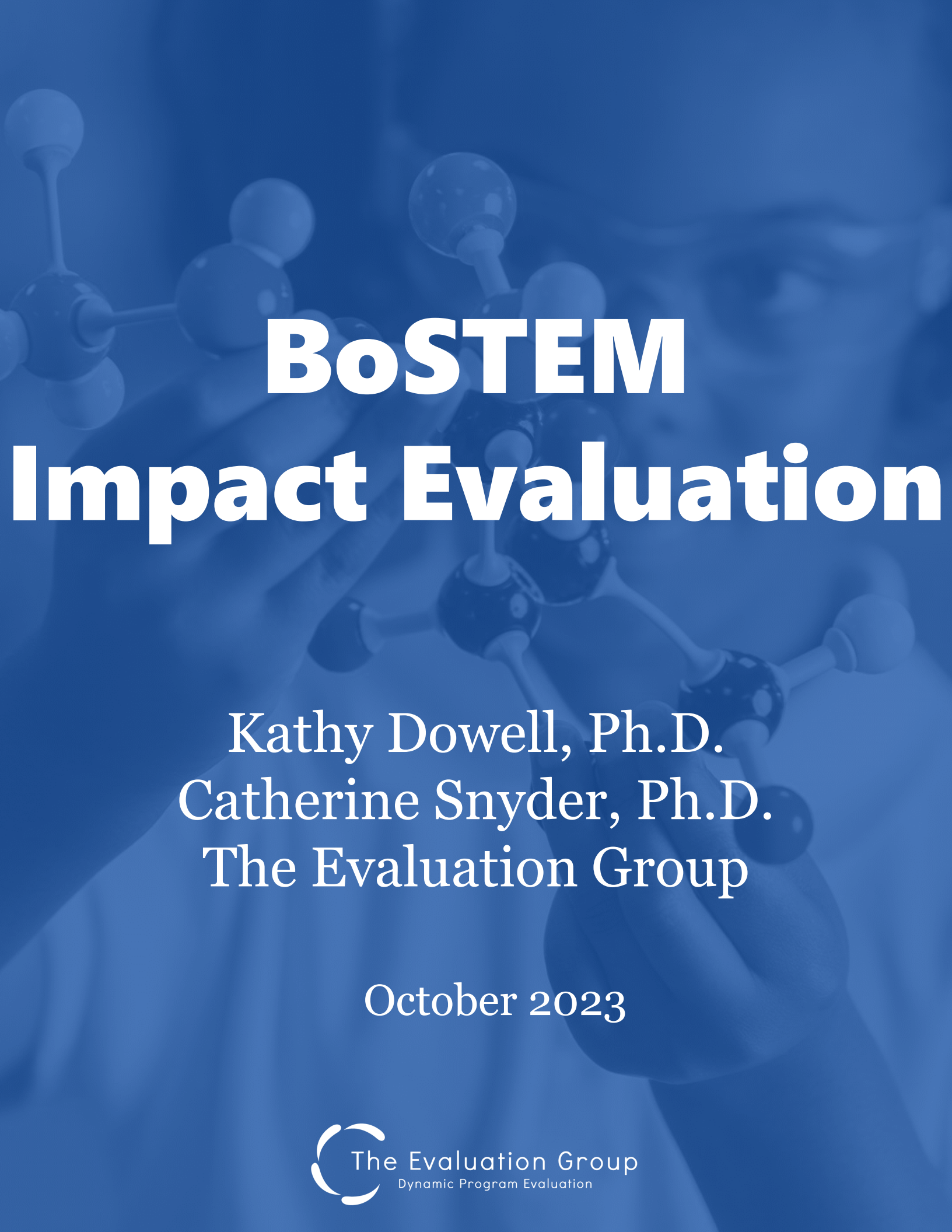


BoSTEM Impact Evaluation

Kathy Dowell, Ph.D.
Catherine Snyder, Ph.D.
The Evaluation Group

October 2023

The Evaluation Group
Dynamic Program Evaluation

BoSTEM

Impact Evaluation Report

Lead Agency: United Way of Massachusetts Bay and Merrimack Valley
9 Channel Center, Suite 500
Boston, MA 02210

Project Director: Joe Rosenbaum

Third-Party Evaluator: Kathy Dowell, Ph.D.
Catherine Snyder, Ph.D.
The Evaluation Group

Contact: Joe Rosenbaum: 617-624-8108, jrosenbaum@supportunitedway.org
Kathy Dowell: 404-556-5621, kathy@evaluationgroup.com
Catherine Snyder: 803-605-2690, cathi@evaluationgroup.com

Grant Period: 10/01/2017 – 9/30/2022, no-cost extension to 6/30/2023

Funder: U.S. Department of Education
Office of Elementary and Secondary Education
Education, Innovation, and Research (EIR) Grant Program

Award #: U411C170195

EIR Cohort Year: 2017

EIR ID: Early09

Funding for this report came from the U.S. Department of Education under its Education Innovation and Research (EIR) initiative within the Office of Elementary and Secondary Education through a grant awarded to United Way of Massachusetts Bay and Merrimack Valley. The EIR grant award required an independent evaluation of the implementation and impacts of the program. The opinions, findings, and conclusions in this report do not necessarily represent the official positions or policies of the funders. Correspondence regarding this document should be addressed to Kathy Dowell, The Evaluation Group, 2607 Woodruff Rd., Suite E#112, Simpsonville, SC 29681; 404-556-5621; kathy@evaluationgroup.com. For information about The Evaluation Group, see our website: www.evaluationgroup.com.

Contents

ABSTRACT

BoSTEM, implemented by United Way of Massachusetts Bay and Merrimack Valley and Boston Afterschool and Beyond, is a network of STEM-focused after school programs in the Boston area that provide high-quality science, technology, engineering, and math (STEM) opportunities to Boston middle school students. Through an innovative citywide coalition of nonprofits, schools, researchers, and industry partners, BoSTEM aims to close the opportunity and achievement gap for youth traditionally underrepresented in STEM through exciting, hands-on learning and career mentorship. The BoSTEM impact evaluation used a quasi-experimental design (QED) to examine the effect of BoSTEM on social-emotional learning skills. The study examined outcomes for students in school years 2020-21 and 2021-22. Outcomes for BoSTEM students were compared to a sample of students who participated in business-as-usual afterschool STEM programs that did not receive the BoSTEM structure of support that included performance feedback, coaching, and professional development opportunities. Findings show there was no significant difference between BoSTEM and comparison students in development of social-emotional learning skills. Challenges with data collection and recommendations for future evaluation studies are discussed.

1. INTRODUCTION

1.1 Background

Convened by Boston After School and Beyond (BASB) and the United Way of Massachusetts Bay and Merrimack Valley (UWMB), BoSTEM was designed to respond to the national need for projects focusing on science, technology, engineering, and math (STEM) education, particularly for members of underrepresented groups. BoSTEM integrates culturally responsive STEM out-of-school-time (OOS) programming, aligned with in-school curricula, to prepare high-need middle school students, academically and social-emotionally, for STEM postsecondary education and careers. Through exciting, hands-on learning and career mentorship, BoSTEM aims to close the opportunity and achievement gap for youth traditionally underrepresented in STEM. In 2017 BoSTEM received an Education, Innovation, and Research (EIR) grant from the U.S. Department of Education in 2017, to test the hypothesis that BoSTEM has a significant impact on academic achievement and development of social-emotional skills.

1.2 Review of Literature

STEM education is the foundation for a skilled STEM workforce. However, in some cases, STEM education is falling short in preparing students for STEM careers. A 2022 report published by the National Science Board called for improvements in K-12 STEM education, as student performance on standardized tests in science and math have not improved in more than a decade (National Science Board, 2022). Further, to advance individual and national prosperity and competitiveness, the U.S. needs "all hands on deck" to modernize K-12 STEM education and to hold itself accountable with reliable, up-to-date data (National Science Board, 2022).

While national demand for skilled STEM workers is rising, U.S. students continue to fall behind in key skill attainment in STEM subject areas such as math and science. The 2018 Program for International Student Assessment (PISA) found that U.S. students ranked 11th out of 79 advanced industrialized nations in science (OECD, 2018). Recent test scores from the National Assessment of Educational Progress (NAEP) indicate only 36% of 4th graders, 26% of 8th graders, and 24% of 12th graders nationally were identified as proficient or advanced in math (National Assessment of Educational Progress, 2023). Student achievement was equally dismal in science, with just 35% of 4th graders, 33% of 8th graders, and 20% of 12th graders rated as proficient or better (National Assessment of Educational Progress, 2023). As these NAEP scores indicate, while students may express an interest and show ability in math and science in the early years, as they advance through their academic trajectory, this interest often wanes and academic achievement declines.

Racial disparities in the STEM workforce are also a concern. While African Americans make up 12.6% of the U.S. workforce, just 8.5% of STEM workers are African American

(National Science Board, 2021). Statistics are similar for Hispanics, who account for 17.8% of the U.S. workforce but only 14.2% of the STEM workforce (National Science Board, 2021). Given the disproportionately low numbers of minorities represented in the STEM workforce, promoting interest in STEM careers, and recruiting, retaining, and graduating minority students with STEM degrees is essential to diversifying the STEM workforce (National Science Board, 2015).

STEM education can also be important for helping students develop social-emotional learning (SEL) skills. Panorama Education describes SEL as "the mindsets, skills, attitudes, and feelings that help students succeed in school, career, and life" (Panorama Education, 2015). The Aspen Institute asserts that supporting social-emotional learning is related to school attendance, grades, test scores, graduation rates, and college and career readiness (The Aspen Institute, 2019). STEM learning may play a role in developing these important skills (National Afterschool Association, 2016). A 2022 study suggested a relationship between technology and arts education infused with SEL content and student learning outcomes (Garner & Gabitova, 2022).

One of The National Science Foundation's goals is to broaden participation in STEM to increase the U.S.'s capacity for innovation (Vogt, Remold, Singleton, & Parker, 2016). BoSTEM hopes to do just that, thereby changing the outlook for the future STEM workforce by inspiring the next generation of STEM professionals in the Greater Boston area. With a primary goal of closing the opportunity and achievement gap for youth traditionally underrepresented in STEM, BoSTEM created a STEM learning ecosystem in Boston by bringing together multiple partners to create meaningful STEM learning experiences for youth. By providing culturally responsive hands-on STEM learning opportunities, providing programs with continuous performance feedback, supporting programs in using innovative strategies, and offering high-quality professional development opportunities for program staff, BoSTEM aims to better prepare high-need middle school students, academically and socially, for STEM postsecondary education and careers.

2. IMPACT STUDY

2.1 Independence of the Impact Evaluation

The Evaluation Group (TEG) conducted the evaluation of BoSTEM in accordance with the guidelines set forth by the U.S. Department of Education. TEG and BASB were responsible for collection of data for both treatment and comparison groups. The data were entered into an online survey system by the staff at each BoSTEM program site. TEG downloaded the data directly from the online system. TEG independently conducted all analyses, and all findings are being reported by TEG without being subject to the approval of the BoSTEM project director or staff who were involved in conceptualizing and implementing the program. TEG's evaluations adhere to the Program Evaluation Standards of the Joint Committee on Standards for Educational Evaluation and to

American Evaluation Association's Guiding Principles. This study was pre-registered on the Registry of Efficacy and Effectiveness (REES) website.

2.2 Study Description

Research question. The BoSTEM impact study was designed to answer the following research question: What is the impact of BoSTEM on program staff perceptions of 6th, 7th, and 8th grade students' SEL skills after one cycle of program exposure for two cohorts of students (enrolled in school year 2020-21/summer 2021 and school year 2021-22/summer 2022) compared to the business-as-usual condition?

Treatment condition. BoSTEM is a city-wide initiative that aims to ensure that every BPS middle-school student has access to high-quality STEM learning opportunities. BoSTEM brings together a coalition of high-performing nonprofits that are committed to closing the achievement and opportunity gaps for students who are traditionally underrepresented in STEM learning, and inspiring and preparing Boston youth to succeed in 21st century careers. This innovative initiative ensures students have access to OOS programming that is culturally responsive, aligned with BPS in-school curricula, and integrates hands-on, experiential learning opportunities. BoSTEM's goals are to increase STEM interest, academic success, and SEL skills.

BoSTEM builds on successful afterschool program strategies and incorporates the characteristics of high-quality afterschool programs identified by research. These strategies include goal setting, strong program management, and sustainability; quality afterschool staffing; enriching learning opportunities; linkages between school day and afterschool personnel; evaluation of program progress and effectiveness; and effective partnerships with community-based organization. Research confirms that children who participate in structured OOS programs offered with significant intensity and duration achieve higher grades in school, attend school more often, and have more positive attitudes toward education than their peers (Afterschool Alliance, 2015). Moreover, OOS learning opportunities have been shown to positively impact academic and behavioral development.

BoSTEM includes four primary components. First, programs complete a **needs assessment and participate in a continuous performance feedback process.** Needs assessments are conducted to identify program strengths and weaknesses. Then, each program develops an action plan tailored to the specific needs of its students. Action plans: a) identify student and program needs, b) detail community partner linkages, c) outline steps necessary for aligning STEM programming with school curricula, d) identify who is responsible for each activity and the timeframe for completion, e) specify resources needed, and f) list indicators of success. A collaborative, continuous performance feedback cycle is employed to encourage and support innovative, customized, program-based strategies and supports within a framework for quality implementation. The BoSTEM Leadership Team meets with each program semi-annually to discuss progress on the plan, celebrate successes, and identify areas for improvement.

The second component is the provision of program-wide professional learning opportunities. BoSTEM provides professional learning opportunities for BoSTEM educators and the classroom teachers who collaborate with them to refine and facilitate curricula and activities that allow students to further connect the STEM concepts learned in the classroom to real-world settings. All BoSTEM program staff and classroom teachers also receive culturally responsive training designed to create more inclusive learning environments and support students who are traditionally underrepresented in STEM.

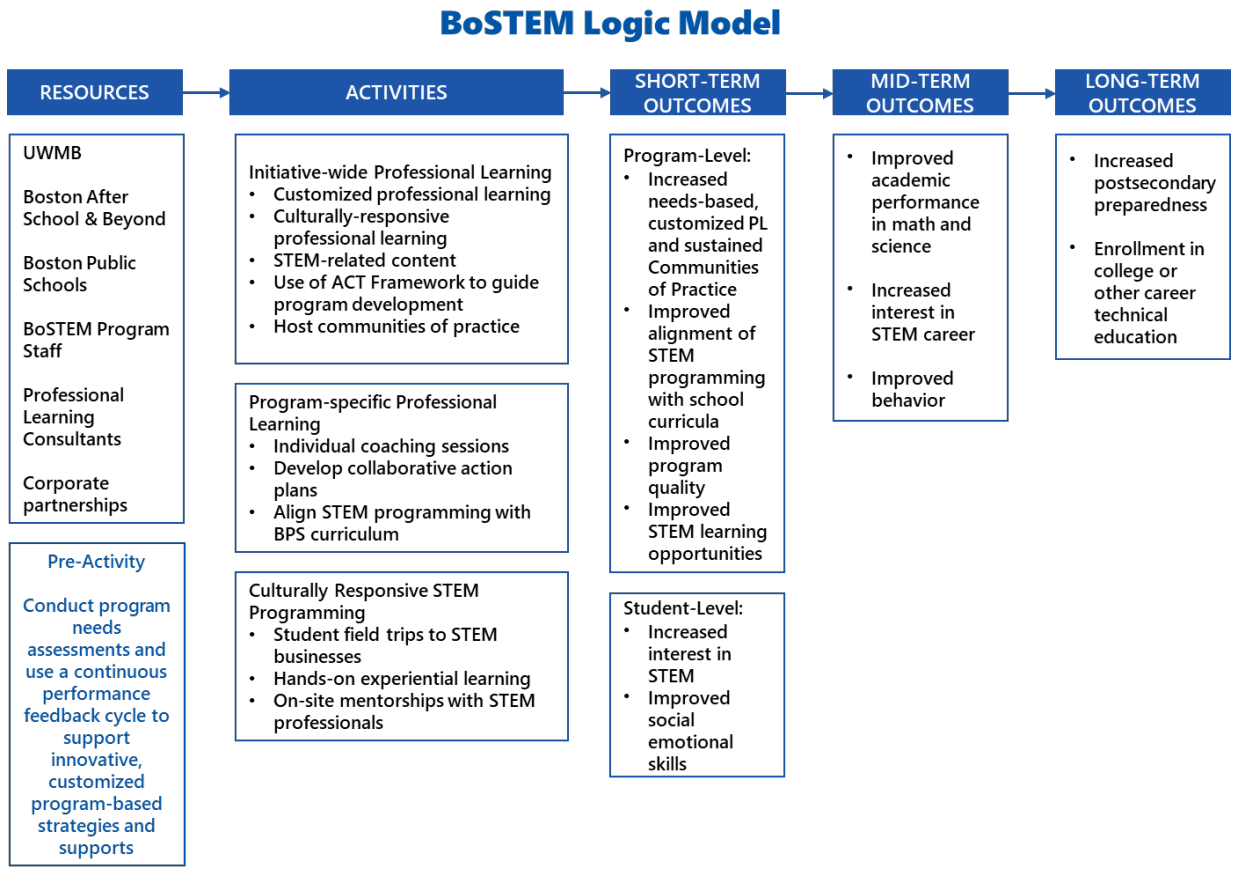
Hosting Communities of Practice built on the Boston STEM Network—a cross-sector communication and collaboration with partners from K-12 education, higher education, industry, OOS programs, and philanthropy, all working in STEM education to address the need for systemic change. They are comprised of BASB staff, professional learning trainers, BoSTEM staff, and UWMB leaders, to review data and feedback and develop data-informed programming. To support the Communities of Practice, the BASB STEM director serves as the liaison between BoSTEM and the district, schools, and partners to: 1) develop, plan, and implement volunteer engagement events to support student learning in BoSTEM programs, 2) refine systems for soliciting, documenting, analyzing, and communicating stakeholder learning gleaned from BoSTEM programming, and 3) work to scale the Communities of Practice and shared-learning work by researching prospective partners, the STEM learning needs of Boston students, and best approaches to teaching and learning STEM to refine professional learning offerings.

Third, BoSTEM provides **program-specific professional learning and coaching.** Educators receive at least two annual individual coaching sessions provided by the project director, STEM director, and/or BASB staff, that are tailored to their specific needs. These program-specific learning opportunities help program staff develop collaborative action plans and align their programming with BPS curriculum.

Finally, BoSTEM implements **culturally responsive STEM programming** that is aligned to the BPS school curriculum. While each program implements unique STEM programming, all BoSTEM programs used the Achieve, Connect, Thrive (ACT) Framework (page 8) to unite Boston's OOS programs around a common youth agenda. The framework outlines the skills that research and practice show are important for youth to have to be prepared and successful in school, careers, and life. Commissioned by Boston's mayor and UWMB, with the support of The Wallace Foundation, the framework provides a common vocabulary to bridge education and youth development, as well as in-school, after-school, and summer learning. The framework also acts as a guide to help BoSTEM programs articulate outcomes and define how they are measured.

Within the ACT Framework, each program provides OOS, project-based, hands-on, experiential STEM learning experiences to build SEL skills proven to increase students' academic success and postsecondary preparedness. Students participate in semi-annual field trips to STEM businesses to observe STEM careers in action and learn from experts in the field. Each program is linked to professionals in the STEM field who are recruited, trained, and placed by UWMB. These professionals provide at least quarterly mentorships and on-site program participation in STEM activities. For example, a microbiologist may have engaged students by facilitating a unit about the role microorganisms play in fixing the nutrients consumed by the vegetables in their garden, and subsequently, by the people who eat them. By creating these connections between programs and STEM professionals, BoSTEM exposes students to careers in which they can apply the skills that they are learning.

Students work in small-group settings to develop hypotheses, design experiments, and test their theories to address real-world challenges. Through Defined STEM, staff assist students with building their SEL skills through real-world videos and tasks that bring industry concepts to them. The BoSTEM logic model is shown on the next page.



BoSTEM programs operate for varying lengths of time, ranging from several weeks to a full school year. Table 1 provides information about programming at the 12 BoSTEM programs.

Table 1. BoSTEM Program Descriptions

Program Name	Description	School Program	Summer Program
Breakthrough Greater Boston	Using a "students teaching students" model, high-achieving high school and college students from diverse backgrounds teach classes to middle school students. Middle school students participate in weekly sessions with academic electives, homework support, after-school tutoring, and hands-on workshops featuring Breakthrough's Full STEAM Ahead curriculum. In addition, a summer program offers core academic classes. New students enter the program in the spring of their 6th grade year.	October - May	July-August

Program Name	Description	School Program	Summer Program
Citizen Schools	Students in Grades 6-8 participate in programming built into an extended school day four days a week at partner schools. Apprenticeships engage students in hands-on learning experiences led by local professionals and community members in topics such as robotics, microbiology, and financial literacy. Students also receive academic support from Volunteers in Service to America (VISTAs) in math and English language arts.	October-May	N/A
Citysprouts	This garden-based learning program cultivates and manages school gardens for educational purposes. Grade 6-8 students meet weekly after school to work and learn in school gardens, study plants and food science, and analyze global food systems and their effects on communities. Classroom teachers may use gardens during the school day.	Fall Program: October - January Spring Program: February - June	July-August
Community Boat Building	After School Mini Boat Makers is a program to engage students in Grades 6-8 in the engineering design process where students design, build, and test model boats. Students learn design principles, integrate mathematics into real world applications, and engage in weekly hands-on activities.	February – June	N/A
Courageous Sailing	Courageous Sailing transforms lives through sailing programs that inspire learning, personal growth, and leadership. Courageous, established in 1987 and serving over 1000 youth annually, is a sports-based youth development program that uses sailing, swimming, and related STEM education as platforms for social-emotional growth and OOS learning. As students master sailing skills, they also build confidence, resilience, teamwork, environmental stewardship, and other skills necessary for success on the water, in the classroom, and in life.	September - December	N/A

Program Name	Description	School Program	Summer Program
East Boston Social Center	This program is based on the Mystery of Matter curriculum, developed by the St. Louis Science Center, and the accompanying Emmy Award winning PBS series based on this curriculum. The Mystery of Matter materials show not only what these scientists discovered, but also how. The curriculum incorporates a hands-on facet by recreating some of the original experiments using similar versions of the lab equipment, and provide opportunities for students to engage in in-depth investigations focused around the periodic table of elements.	Fall Program September – January Spring Program Febraury - June	N/A
HMS MEDscience	HMS MEDscience is an innovative biology course designed as a student-centered learning experience utilizing mannequin-based simulated clinical cases integrated with and supported by a rigorous organ system curriculum. The program immerses students in realistic, dynamic, team-based, simulated medical emergencies. The curriculum motivates students to think critically, communicate succinctly, and work collaboratively in teams. The goal is to increase student interest and achievement in the STEM disciplines and inspire them to pursue further exploration of health care fields of study and professions.	Fall Program September – December Spring Program Febraury - May	N/A
Latino STEM Alliance	This afterschool robotics program for Grades 6-8 meets weekly for students to undertake a series of design challenges that teach students engineering, robotics, and programing principles with Lego Robots. After building, testing, assessing, and redesigning their robots, students reflect on their application of the design process to form an understanding of how real engineers work to find solutions. A team robot is developed to compete in a Lego competition.	October-May	N/A

Program Name	Description	School Program	Summer Program
Mass General Hospital (MGH)	The Science Fair Mentor Program pairs students in Grades 7-8 with MGH mentors to help them complete science fair projects. Pairs meet bimonthly. Mentors help students define research questions, collect, and analyze data, and present their results. Most mentors are clinical researchers and lab technicians. After the science fair, students can stay connected to their mentor via Big Brothers Big Sisters. Graduating Grade 8 students may participate in paid summer internships at MGH.	October-March	N/A
Sociedad Latina	Students in Grades 6-8 participate in STEAM service-learning experiences based on current community issues and student interests. For example, during one unit students participated in an engineering design challenge in which they developed models of energy efficient homes. The program offers homework help via college tutors.	October-May	July-August
Thompson Island Outward Bound Education Center	Situated on the Boston Harbor Islands National Park, the Education Center offers place-based science learning experiences to students in Grades 6-8 and integrates curriculum into partner schools. During the program, staff members visit classrooms and conduct 11-15 days of instruction to prepare students for island visits. On the island, students study the wildlife, biodiversity, geology, and agents of erosion. Students spend 11 days on the island, including overnight in Grades 7-8 and receive 11-15 days of classroom instruction.	September – June	July-August
West End House (WEH)	WEH delivers a robust pathway of STEM opportunities that is designed to spark interest in STEM in elementary school, foster higher-level engagement in middle school, and position high school teens to pursue post-secondary education and careers in STEM. WEH provides a diverse range of high-impact	October - June	June-August

Program Name	Description	School Program	Summer Program
	programming including robotics, coding, botany, biology, chemistry, and engineering and design. WEH is able to deliver broad exposure to many STEM disciplines, as well as opportunities for youth to advance their skillset with higher-level engagement.		

Programs were selected to participate in the BoSTEM impact study based on the following criteria:

- Served youth in the 6th, 7th, and/or 8th grades;
- Provided high-quality programming that focused on engaging, hands-on STEM learning;
- Had prior relationships with UWMB, BASB, or BPS;
- Had an ability to collect data using required tools;
- Served a majority of underprivileged, minority youth; and
- Were implementing the BoSTEM program with a high level of fidelity.

Based on these criteria, UWMB and BASB identified eight (of 12) BoSTEM programs that were eligible to participate in the impact study.

It was expected that the degree to which the BoSTEM program was implemented in accordance with the program model and theory would have a direct impact on student outcomes. To assess implementation fidelity, a BoSTEM fidelity index was developed to monitor and document program activities, specifically the extent to which actual project implementation aligned with planned implementation.

The fidelity index addressed three components: 1) program-wide professional learning, 2) site-specific professional learning, and 3) culturally responsive STEM learning. Each fidelity component included indicators of implementation organized by strategies that supported each component (see Table 2).

Table 2. BoSTEM Fidelity Index Components

Fidelity Index Component	Strategies
Initiative-wide Professional Learning	**Professional Learning**: Targeted staff at BoSTEM sites received professional learning opportunities. **Culturally Responsive Professional Learning**: Targeted staff at BoSTEM sites participated in BoSTEM-sponsored, culturally responsive professional learning opportunities. **Use of ACT Framework**: BoSTEM sites developed programming based on the ACT Framework. **Communities of Practice**: BoSTEM hosted communities of practice.
Site-specific Professional Learning	**Individual Coaching Sessions**: Targeted staff at BoSTEM sites received individual coaching from the BoSTEM partnership. **Action Plans**: Leadership Team collaborated with site staff to develop, review, and/or revise Action Plans. **Curricular Alignment**: BoSTEM sites aligned their curricula with the BPS curricula.
Culturally Responsive STEM Learning	**Field Trips**: Students participated in field trips. **Hands-on Experiential Learning**: Students participated in hands-on experiential learning opportunities. **Mentoring**: BoSTEM provided mentoring opportunities to students.

Within each strategy were indicators of implementation with minimum thresholds for determining "adequate" fidelity. For each program component, fidelity scores were computed to provide a comprehensive assessment of the implementation of each component. Component fidelity scores were summed to compute an overall program score. Scores were categorized as low fidelity (<50% of points earned), moderate fidelity (50%-79% of points earned), or high fidelity (80%-100% of points earned). Tables 3 and 4 summarize the fidelity results for the two-year study period. Moderate fidelity was achieved in the 2020-21 school year, with low fidelity in school year 2021-22. For both years, culturally responsive STEM learning was implemented at low fidelity. Professional learning was implemented with low fidelity in Year 5.

Table 3. BoSTEM Fidelity Index Scores: Grant Year 4, School Year 2020-21

Component	Fidelity Score	Fidelity Level
Initiative-wide Professional Learning	81%	High
Site-specific Professional Learning	50%	Moderate
Culturally Responsive STEM Learning	44%	Low
Year 4 Overall Program Score	**61%**	**Moderate**

Table 4. BoSTEM Fidelity Index Scores: Grant Year 5, School Year 2021-22

Component	Fidelity Score	Fidelity Level
Initiative-wide Professional Learning	57%	Moderate
Site-specific Professional Learning	27%	Low
Culturally Responsive STEM Learning	14%	Low
Year 5 Overall Program Score	**35%**	**Low**

Comparison Condition. Comparison programs were chosen to participate based on the same criteria that were used to identify the treatment programs; they served youth in 6th, 7th, or 8th grades; provided high quality programming that included engaging, hands-on STEM programming; had prior relationships with UWMB, BASB, or BPS; had the ability to collect data using the tools we required; and served a population that was mostly underprivileged, minority youth. In many cases, students were required to attend the school in which the program was operating, and/or meet criteria related to race, ethnicity, and/or income. Comparison programs were not provided with the supports and resources provided to the treatment programs (i.e., targeted professional learning and coaching opportunities); they did not utilize the BoSTEM collaborative, continuous performance feedback cycle to develop and implement innovative, customized, program-based instruction; and they did not have access to the BoSTEM-sponsored culturally responsive career connection activities (i.e., field trips and mentoring).

Programming. Both treatment and comparison programs operated over the course of the school year and/or for approximately 6 weeks over the summer. Two BoSTEM programs operated during the school year and three offered summer programming. Two of the programs provided programming at both times; however, there were no cases where a student in the analysis took part in both the school year and summer program.

Three comparison programs operated school year programs and four operated summer programs. Two comparison programs offered programming at both times; however, there were no cases where a student in the analysis participated in both the school year and summer programs.

Study Participants. All students who enrolled at the eight selected BoSTEM programs during Years 4 and 5 of the grant were invited to participate in the impact study. To participate in a treatment program, students needed to be BPS students, in or entering 6th, 7th, or 8th grade, not previous participants in BoSTEM programming, and have submitted a signed parent consent form and student assent form. Based on these criteria, the study included 38 treatment students from four BoSTEM programs (City Sprouts, Community Boat Building, Courageous Sailing, Sociedad Latina).

Students who participated in comparison programs made up the comparison group. These students also needed to be BPS students, in or entering 6th, 7th, or 8th grade, and must have submitted a signed parent consent form and student assent form. The study included 93 students from five comparison programs.

Sample alignment with those served by BoSTEM. Difficulties in getting parental consent resulted in a small percentage of BoSTEM students being included in the studies. This study included 38 BoSTEM students, representing less than 5% of all students served across the two study years.

2.3 Design and Measures

Study design. The study used a multi-year, multiple-cohort, clustered, quasi-experimental design (QED) to examine the impact of BoSTEM programming on social-emotional skills.

Measures. The outcome of interest was the mean score across six domains of SEL skills. SEL data were collected via the Survey of Academic and Youth Outcomes – Teacher Version (SAYO-T) (National Institute on Out-of-School Time, 2013). The SAYO-T asks program staff to rate how often a student exhibits specific behavior patterns using a scale from 1 (never) to 5 (always). Details about each domain are shown in Table 5.

Table 5. Domains of the SAYO-T

SAYO-T Domain	Number of Items	Sample Items
Self-Regulation	5	▪ Works well independently when expected to do so ▪ Is able to regain control of behavior or adjust behavior when given warning
Perseverance	6	▪ Sets goals for self ▪ Sticks to a plan to complete a task
Critical Thinking	7	▪ Is able to analyze relationships between ideas or concepts ▪ Draws conclusions after considering all evidence
Communication	5	▪ Volunteers to ask a question or answer a question during group time ▪ Demonstrates active listening skills (e.g., is able to summarize key points of speaker)
Relationships with Peers	6	▪ Forms friendships with peers ▪ Is able to compromise with peers during times of disagreement or conflict
Relationships with Adults	7	▪ Discusses special interests or ideas with staff member or teacher ▪ Is able to disagree with, or question, adults in a respectful and friendly manner

The SAYO-T domain outcomes of interest are listed in Table 6, aligned to the eligible WWC outcome domains (WWC, 2021).

Table 6. Alignment of BoSTEM SEL Domains to WWC Outcome Domains

BoSTEM SAYO-T SEL Domain	WWC Outcome Domain	WWC Outcome Domain Description
Self-Regulation	Intrapersonal Competencies	Mental health indicators that are primarily focused inward and reflect a student's emotional status and psychological well-being, and that include internalizing behaviors and both negative and positive feelings. Outcomes in this domain include anxiety, depression,

BoSTEM SAYO-T SEL Domain	WWC Outcome Domain	WWC Outcome Domain Description
Perseverance	Intrapersonal Competencies	loneliness, and thought disorders, as well as emotional regulation, happiness, motivation, self-concept, self-efficacy, self-regulation, and overall adjustment. Measures may be based on a self-report, educator observation, or results from an assessment scale.
Critical Thinking	Cognition	The process through which an individual obtains and processes knowledge or conceptual understanding, including abstract reasoning, concept formation, critical thinking, executive function skills, general problem solving, logical thinking, memory, metacognition, spatial ability, symbolic learning, and IQ.
Communication	Expressive Communication	Communicating words or ideas using developmentally appropriate spoken English, assistive devices, sign language, or non-verbal cues.
Relationships with Peers	Student Behavior	Observable behaviors that conform or fail to conform to developmentally appropriate behavioral norms, rules, or expectations within school or in the community. Examples of positive and prosocial outcomes in this domain include participating in class or in extracurricular activities, paying attention, respecting others, staying on task, and other measures of interpersonal engagement, social functioning, or time management.
Relationships with Adults	Student Behavior	

SAYO-T observations were made within the first two weeks of a program starting, and again during the last few days of programming. Program staff logged into an online data collection system to enter their observational ratings for each student. The outcome was the mean score across the six SEL domains. Mean scores could range from 1 to 5, with higher scores indicating stronger SEL skills. Table 7 shows the data collection details for this study.

Table 7. Data Collection Details

School Year	Consent Collected	Baseline Collected	Outcome Data Collected	Grade Levels Included
2020-21 (includes summer 2021)	Within two weeks of student starting a program	Within two weeks of student starting a program	At end of program	6th-8th
2021-22 (includes summer 2022)	Within two weeks of student starting a program	Within two weeks of student starting a program	At end of program	6th-8th

3. DATA ANALYSIS AND FINDINGS

3.1 Data Analysis

Establishing baseline equivalence. To assess baseline equivalence of the treatment and comparison samples, we calculated the standardized baseline mean difference between the BoSTEM group and the comparison group (Hedges' g). We considered baseline equivalence to be established if the standardized mean difference between treatment and comparison students on baseline SEL mean scores was less than or equal to 0.05 (What Works Clearinghouse, 2022). Hedge's g was 0.18, falling into a range where the WWC requires statistical adjustment for baseline equivalence. We included students' baseline SEL mean score in the analytical model as statistical adjustment. See Appendix A for a table showing results of the baseline equivalence assessment.

Program effects analysis model. A two-level linear model was used to estimate program impact on students' SEL skills, with students nested in programs. Students with missing baseline or outcome data were excluded from the analysis. The unit of assignment and the unit of analysis were both student-level. There was no imputation of outcome or baseline data.

Table 8 describes the covariates included in the analysis. A blocking variable for program was included in the impact analysis model to account for differences in program characteristics. We also included a variable representing the length of the program (school year or summer).

Table 8. Impact Study Covariates and Blocking Variable

Variable	Description	Type of Measure	Data Source
Program	Identified which program a student attended	Nominal	BoSTEM program records
Baseline Mean SEL Score	Mean score across six domains of SEL skills	Continuous	SAYO-T completed by program staff
Treatment	Identified whether a student was a BoSTEM student or a comparison student	Binary 0 = Comparison 1 = BoSTEM	BoSTEM program records
Length of Program	Block identifying if the program length was school year or summer	Nominal	BoSTEM program records

The linear model used for conducting the analysis is shown below.

$$Y_{ij} = \alpha + \beta_0 + \beta_1 Treatment_j + \beta_2 Baseline_{ij} + \beta_3 Program_{ij} + \beta_4 Length_i \beta_4 + \mu_j + e_{ij}$$

Where:
Y_i = the outcome for student *i*

α = the intercept

$\beta_1 Treatment_j$ = covariate adjusted difference in the mean student outcome for treatment group students minus the mean student outcome for comparison group students (1 = treatment and 0 = comparison)

$\beta_2 Baseline_{ij}$ = parameter estimate for the effect of student baseline score

$\beta_3 Program_{ij}$ = parameter estimate for the effect of the program

$\beta_4 Program_i$ = parameter estimate for the effect of length of the program

ε_i = a random error term for student *i*

3.2 Findings

Results indicated no statistically significant difference between the BoSTEM treatment students and the comparison students on SEL skills (mean score of 4.21 vs. 4.36, respectively). Baseline SEL score was statistically significant and reflects the fact that baseline SEL skills is a significant predictor of outcome SEL skills; this is an expected result. There was no statistically significant difference for length of program. Table 9 includes the model output. See Appendix B for a table showing additional information from the SEL analysis results.

Table 9. BoSTEM SEL Analysis

Variable	Estimate	Standard Error	*t*-value	*p*-value
Intercept	2.095	0.299	7.01	.000
SEL Baseline Score	0.538	0.068	7.929	.000
Treatment	0.103	0.205	0.505	.642
Program Length	0.057	0.108	0.532	.596

4. DISCUSSION

Through BoSTEM, UWMB and BASB provided coaching and professional development to OOS STEM program staff and real-world STEM experiences for students in Grades 6-8. In this impact study, BoSTEM students were compared to students receiving business-as-usual STEM programming at other OOS programs within the BPS school district. Hierarchical linear modeling with blocks for program and timing of program (school year versus summer) was conducted to determine the effect of BoSTEM interventions on SEL skills. Our results suggest that BoSTEM did not have an impact on students' SEL skills.

There are two primary issues that likely contributed to the lack of significant results. First, the BoSTEM program was not implemented with a high level of fidelity during the two study years. BoSTEM was implemented at a moderate level of fidelity in the first year of the study and at a low level during the second year. More importantly, in both years, there was a low level of fidelity of implementation of the culturally responsive STEM programming component that was most likely to have an impact on SEL skills.

The second issue was the very small sample size. One reason for this was that study eligibility requirements made many programs and students ineligible to participate in the study. For example, students who had previously participated in BoSTEM, were not in Grades 6-8, or were not in BPS schools were not eligible to participate in the study. BoSTEM programs served many students who did not meet these requirements and were not included in the study. A second reason for the low sample size was challenges in obtaining parental consent and student assent to participate in the study, as required by

BPS. After closing in the spring of 2020 for the COVID-19 pandemic, BoSTEM provided remote programming in school year 2020-21, which hindered efforts at obtaining parental consent and student assent, as remote programming made it difficult for program staff to connect directly with parents and collect consent forms. Remote programming also precluded effective school partnerships, which some programs relied on for consent distribution and collection. School staff struggled to connect with families and were juggling new burdens around teaching remotely, and thus they experienced challenges with distribution and collection of consent/assent forms. When connections with parents were made, many parents remained unresponsive to requests for signed consent forms. Despite making changes to potentially improve the consent process, such as creating an electronic consent form and simplifying the language used in the form, consent collection remained a major challenge. We estimate that less than 5% of students served by BoSTEM programs were included in the study.

While our small sample size did not allow for subgroups analyses, the interaction of treatment effects with gender and minority status should be investigated further. Future analyses should also follow subgroups of students who participate in a BoSTEM program over multiple years to see if longer participation has an impact on SEL skills.

REFERENCES

Afterschool Alliance. (2015). *Taking a deeper dive into aftershool.* Washington DC: Afterschool Alliance.

Bidwell, A. (2013). STEM workforce no more diverse than 14 years ago. Retrieved from https://www.usnews.com/news/stem-solutions/articles/2015/02/24/stem-workforce-no-more-diverse-than-14-years-ago

Boston STEM Network. (2013). Retrieved from http://bostonstemnetwork.org/

Carnevale, A., Smith, N., & Strohl, J. (2013). *Recovery: Job growth and education requirements through 2020*. Washington, DC: Georgetown University Center on Education and the Workforce.

Change the Equation. (2016). Retrieved from http://www.changetheequation.org/

Institute of Education Sciences. (2020, 09 04). *What Works Clearinghouse*. Retrieved from National Center for Education Evaluation and Regional Assistance: https://ies.ed.gov/ncee/wwc/

Jimenez, L., Sargard, S., Morales, J., & Thompson, M. (2016). *Remedial education: The cost of catching up*. Washington DC: The Centger for American Progress.

Kena, G., Masu-Gillette, L., Robinson, J., Wang, X., Rathbun, A., Zhang, J., . . . Velez, E. (2015). *The condition of education 2015*. Retrieved from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2015144

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2010). *Rising above the gathering storm: Revisited*. Washington, DC: The National Academies Press.

National Assessment of Educational Progress. (2017). *2015 science and math national assessment of educational progress results*. Washington, DC: National Center for Education Statistics.

National Center for Educational Statistics. (2016). *Fast facts*. Washington, DC: Institute of Education Sciences, National Center for Education Statistics.

National Institute on Out-of-School Time. (2013). *Psychometric testing of the Survey of Academic and Youth Outcomes: Teacher*. Wellesley, MA: National Institute on Out-of-School Time.

National Science Board. (2015). *Revisiting the STEM workforce*. Washington, DC: The National Science Foundation.

OECD. (2016). *Country note: Key findings from PISA 2015 for the United States*. Retrieved from http://www.oecd.org/pisa/PISA-2015-United-States.pdf

U.S. Congress Joint Economic Committee. (2014). *STEM education for the innovative economy*. Washington, DC: U.S. Congress Joint Economic Committee.

U.S. Department of Education. (2016). *Fact sheet: Spurring African-American STEM degree completion*. Washington, DC: U.S. Department of Education.

What Works Clearinghouse. (2020). *What Works Clearinghouse Standards Handbook, Version 4.1*. Washington D.C.: U.S. Department of Education, National Center for Education Evaluation and Regional Assistance.

What Works Clearinghouse. (2021). *Study Review Protocol, Version 1.0 (January 2021)*. Washington D.C.: U.S. Department of Education.

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. Retrieved from https://ies.ed.gov/ncee/wwc/Handbooks

Wilson, V. (2016). *People of color will be a majority of the American working class in 2032*. Washington DC: Economic Policy Institute.

Appendix A
Baseline Equivalence Results

Measure	Comparison Sample Size	Comparison Mean	Comparison Standard Deviation	Treatment Sample Size	Treatment Mean	Treatment Standard Deviation	Treatment-Control Difference	Standardized Difference
SEL	93	3.83	0.76	38	3.69	0.72	-0.14	0.18

Appendix B
Impact Analysis Results

Outcome Measure	Comparison Sample Size	Comparison Mean	Comparison Standard Deviation	Treatment Sample Size	Treatment Model-adjusted Mean	Treatment Standard Deviation	Treatment – Control Difference	Standardized Difference	p-value
SEL	93	4.36	0.71	38	4.21	0.63	-0.15	0.22	.642