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Building Opportunities and Overtures in Science and Technology: Establishing an Early Intervention, Multi-level, Continuous STEM Pathway Program

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ABSTRACT: Building Opportunities and Overtures in Science and Technology (BOOST) is an early intervention, multi-level, continuous STEM pathway program. Born out of a partnership between Duke University and Durham Public Schools, the BOOST program provides 6th through 8th grade students underrepresented in STEM fields with interactive, in-depth explorations of STEM education and STEM careers. BOOST uniquely provides program continuity through high school, undergraduate, and graduate leadership programming. The purpose of this article is to characterize the components of the BOOST program including program background, principles, structure, timeline, and leadership opportunities. BOOST highlights the benefits of integrating early intervention and continuity into the framework of STEM pathway programs. We hope that lessons learned from this program will inform existing programs and encourage the creation of future early intervention, multi-level, continuous STEM pathway programs.

INTRODUCTION

Racial inequities exist across all Science Technology Engineering and Mathematics (STEM) fields. A report by the National Science Foundation (NSF) suggests that the proportion of under-represented minorities (URMs) in science and engineering is less than 30% of their non-URM counterparts, with this number decreasing further in the fields of mathematics, statistics, and physics (NSF, 2019). Underlying this representational gap are complex factors that include socio-economic disadvantages (Caro et al., 2015; Taningco et al., 2008), limited access to role models (Lawner et al., 2019; Simard, 2009), inadequate science instruction (Rainey et al., 2019; Bell et al., 2009) and pervasive achievement gaps in early education (Gándara, 2006; NSF, 2018). STEM outreach programs have emerged as a way to address these complex challenges by preparing students through relevant and engaging curricula for early and sustained success in STEM.

To prevent long-term educational inequities, many STEM programs center their efforts around students at the high school and university level, yet career aspirations are developed as early as elementary school (Magnuson and Starr, 2000). Furthermore, national trends indicate that educational disparities are already profound at these stages. In fact, disparities in academic performance between URM and non-URM students begin as early as the elementary school level (Gándara, 2006; NSF, 2018), and interest in pursuing STEM careers drops across middle, high school, and undergraduate levels (Garcia and Weiss, 2017), highlighting the need for interventions that span these critical time points.

An additional issue tackled by STEM programs is the lack of a sense of belonging among URM students (Rainey et al., 2019; Smith et al., 2013). While a sense of belonging is composed of many factors, adequate role models and compatible learning environments stand out as two important determinants. Indeed, previous studies have shown that despite their widespread use in STEM fields, "top-down" models of lectureship and mentoring are not optimal for all types of learners, and URMs particularly benefit from dynamic learning environments in which they are more closely engaged with other URM mentors (Fries-Britt et al., 2010; Palmer et al., 2011). A potential way to address the lack of role models while providing a more dynamic learning en-

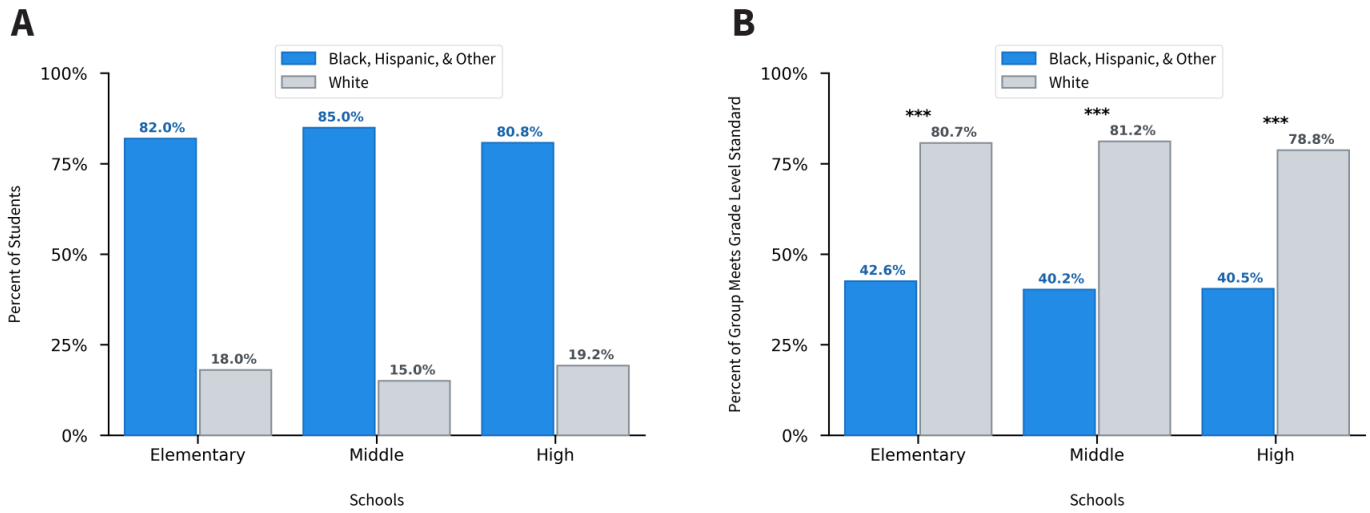

Figure 1. Distribution and Differential Performance of Racial/Ethnic Groups in Durham Public Schools - (A) Students who identify as Black, Hispanic, or Other make up 82%, 85% and 80.8% of the population at the elementary, middle, and high school levels respectively. (B) The percent of students who identify as Black, Hispanic, and Other and meet grade level standards is significantly lower than the percent of students who identify as white and meet grade level standards. This significant difference exists at the elementary, middle, and high school levels. ($^{***}p < 0.001$)

vironment is near-peer mentorship (M. K. Anderson et al., 2015). Near-peer mentoring is centered on students' social identities, connecting them to appropriate role models from similar groups in order to increase interest, learning, and ultimately persistence (M. K. Anderson et al., 2019). In light of the community-building benefits of near-peer mentorship, it is desirable to incorporate its principles into STEM programs.

In this article, we describe Building Opportunities and Overtures in Science and Technology (BOOST), an immersive early intervention, multi-level, continuous STEM pathway program that serves students starting in middle school spanning through the graduate level. BOOST utilizes experiential learning and near-peer mentorship to encourage academic achievement, persistence in STEM education, and ultimately careers as leaders in STEM. In the following sections, we will characterize the background, principles, structure, timeline, and leadership of the BOOST program at Duke University.

METHODS

Program Background. BOOST aims to address the performance gap between Black and Hispanic students and their white counterparts by providing a STEM pathway program for underserved populations. The BOOST program was founded in 2004 within the Duke University School of Medicine (DUSOM) by the late Dr. Brenda E. Armstrong, one of the first Black women to attend Duke University as an undergraduate, and the second Black woman in the United States to become a board-certified pediatric cardiologist. With a strong conviction for promoting diversity and inclusion in medicine, Dr. Armstrong founded BOOST to ensure that Durham County students who are underrepresented minorities in the sciences have the opportunity to explore their passion for STEM.

Durham County, North Carolina is a prime example of the United States' increasing diversity. Of Durham County's estimated 316,739 residents, 36.9% are African American, 13.7% are Hispanic, and 43% are of white non-Hispanic background. The remaining 6% include American Indian, Alaska Native, Asian, Native Hawaiian and other Pacific Islander, and residents who identify as two or more races (United States Census Bureau, 2019).

The diversity in Durham County is reflected in the schools: students who identify as Black, Hispanic, or Other (Multiracial, Asian, American Indian, Hawaiian/Pacific Islander) make up the vast majority of the Durham Public School (DPS) student body. The 2018 - 2019 DPS school year report shows over 80% of DPS students identify as Black or Hispanic at the elementary, middle, and high school levels (Figure 1A). While students who identify as Black and Hispanic represent the vast majority of the DPS student body, students who identify as Black and Hispanic dramatically underperform on standardized tests relative to their peers that identify as white. This stark difference in school performance exists at the elementary, middle, and high school levels ($p<0.001$) (Figure 1B). These data were pulled from the North Carolina Department of Public Instruction (North Carolina Department of Public Instruction, 2019). The percent of students that meet grade level standard was calculated from the Performance Composite; the Performance Composite is a state-defined measure of all standardized tests taken that year. Differences between groups within elementary, middle, and high schools were assessed with a one-tailed binomial test.

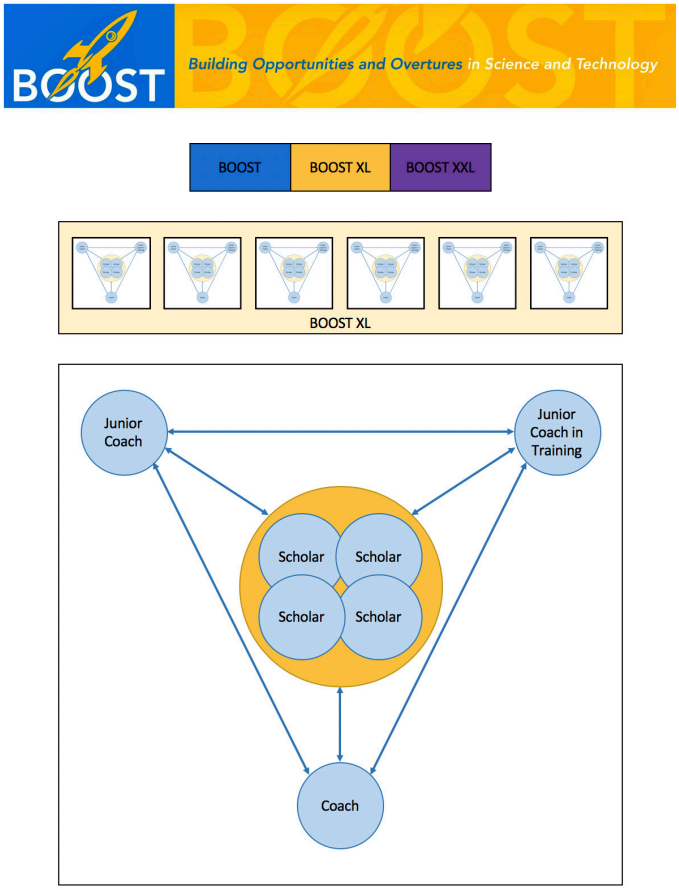

Figure 2. BOOST cohorts. Scholars, Junior Coaches in Training (JCiTs), Junior Coaches (JCs), and Coaches serve in one of the 3 BOOST program cohorts. Each cohort (BOOST, BOOST XL, BOOST XXL) is composed of approximately 6 squads. Within each squad there are seven members including 1 Coach, 1 JC, 1 JCiT, and 4 Scholars.

BOOST recruits students who are underrepresented minorities (URM) in STEM and/or disadvantaged students (DIS). Based on the NIH and NSF shared definition of underrepresented in biomedical research, URM includes students who identify as female, Blacks or African Americans, Hispanics or Latinos, American Indians or Alaska Natives, Native Hawaiians, Pacific Islanders, and students who identify as coming from disadvantaged backgrounds (NIH, 2020). BOOST defines DIS students as the population of DPS students eligible for reduced or free school lunch. Since its inception, BOOST has expanded its partnerships within Duke University, with other local universities and with local community organizations. BOOST's unique position allows us to provide a platform for similar youth-serving community organizations, overall expanding impact, access, and opportunity for kids in Durham. In recent years, BOOST has served as a program and community connector by aiding new program initiatives to tailor their curriculum and making connections to local community members and resources. Financial support for BOOST has been provided through internal institutional support and philanthropic donations with the majority of funding provided through external grants (National Institutes of Health: Science Education Partnership Award (SEPA); Burroughs Wellcome Fund: Student STEM Enrichment Program (SSEP).

Table 1. *BOOST Terminology and definitions.*

Term	Definition
Scholars	
BOOST	6th grade cohort of Scholars
BOOST XL	7th grade cohort of Scholars
BOOST XXL	8th grade cohort of Scholars
Leaders	
Junior Coaches in Training (JCiTs)	High school volunteers, generally freshman and sophomore students, who lead Scholars through program activities
Junior Coaches (JCs)	High school participants, generally junior and senior students, who lead Scholars and JCiTs through program activities
Coaches	Undergraduate, graduate, and professional school students, who lead Scholars, JCs, and JCiTs through program activities
Science Saturdays	8 sessions throughout the year where Scholars and Leaders engage in science projects and attend research field trips
Cohort	A group of Scholars based on grade level. Each cohort (BOOST, BOOST XL, BOOST XXL) is composed of approximately 6 squads
Squad	A group within each cohort. Within each squad there are seven members including 1 Coach, 1 Junior Coach (JC), 1 Junior Coach in Training (JCiT), and 4 Scholars

To date, the BOOST program has recruited over 600 middle school Scholars. Once recruited to the program, Scholars work in grade level-based cohorts that are further divided into small teams or squads. Squads consist of three or four middle school Scholars, one or two high school Junior Coaches in Training (JCiTs) or Junior Coaches (JCs), and one undergraduate or graduate school Coach (Figure 2). The squad-based structure of the BOOST program is designed to foster strong near-peer relationships between Scholars and their Coaches, and create a sense of family within and between the different cohorts. Individual squads work together to hypothesize, design, and analyze the results of a year-long science research project. To provide a better understanding of key BOOST terminology, terms and definitions are listed in Table 1.

Program Principles. The BOOST program is structured based on three key principles: knowledge acquisition, experiential learning, and reflection. In concert, these principles place our Scholars in a strong position to become future leaders in STEM, working against inequities established by lack of exposure to STEM education and resources (Figure 3).

Figure 3. BOOST Program Core Principles. The BOOST Program core principles include knowledge acquisition, experiential learning, and reflection which work in concert to prepare Scholars to become leaders in STEM. By moving up in the BOOST program, Scholars have the opportunity to practice STEM leadership as JCiTs, JCs, and Coaches. BOOST continues to educate its leaders using the same core principles.

The first key principle of BOOST is knowledge acquisition and practice, including introduction to the scientific method. Through BOOST Science Saturdays, Scholars familiarize themselves with key STEM terminology including terms related to their chosen project and terms of the scientific method. In this way they can see how scientific concepts apply as they perform their own experiments. JCiTs, JCs, and Coaches often lead lessons explaining the scientific concept at the center of each Science Saturday, both in large and small groups. As they learn STEM terminology, Scholars learn to develop scientific questions. Based on their questions, Scholars formulate hypotheses to answer their questions. Scholars learn how to design their own experiments to test their hypotheses, collect their own data, and analyze the results to develop their own conclusions.

The second key principle of BOOST is experiential learning. To complement our Scholars' classroom-based school curriculum, BOOST utilizes Science Saturdays and field trips to engage Scholars through hands-on learning opportunities. BOOST Coaches, JCs, and JCiTs guide their scholars through engaging short-term activities such as glow stick chemistry, how to create a rainbow of fire, capillary action in plants, and the chemistry of bioluminescence. Coaches, JCs, and JCiTs review the questions being addressed in the experiment, ask Scholars to hypothesize answers, have Scholars aid in performing the experiments, and then determine how conclusions were drawn. Later in the day, Scholars break out into their squads to work on their year-long experiments. Here, Scholars can practice applying their newly acquired knowledge to the design of their own independently run scientific experiments.

The third key principle is reflection. Fostering our Scholars to become future leaders in STEM requires carving out time for reflection. As part of every BOOST programming event, Coaches, JCs, and JCiTs are encouraged to intersperse reflective questioning into their curricula. Questions prompt Scholars to reflect introspectively on their identity and the root causes underlying health disparities, college education, and careers in STEM, thereby reinforcing the importance of pathway programs like BOOST. Through student mid and end of year written surveys, students have an additional opportunity to reflect on themselves, their growth, as well as their experience within the BOOST program.

With these principles in mid, the overall goal of the BOOST program is to prepare our Scholars for future careers as leaders in STEM. After completion of the program, Scholars have the opportunity to practice STEM leadership by applying for high school leadership positions, first as JCiTs, then as JCs. In their post-high school years, Scholars often are invited to serve as Coaches. BOOST continues to educate leaders using the same three core principles. In the spirit of knowledge acquisition, our leaders receive formal education in leadership through the Duke University Feagin Leadership Program. In the lens of experiential learning, BOOST leaders have consistent experience leading their Scholars through regular program activities. Through reflection, BOOST encourages its leaders to take time after every program event to consider what they did well, what could have gone better, and how they can continue to improve. By encouraging knowledge acquisition, experiential learning, and reflection, BOOST continues to equip their leaders for future careers as leaders in STEM.

Program Structure and Timeline. The BOOST Scholars are selected from a pool of applicants, participate in a series of Science Saturdays following a Launch event and orientation activities, and present their work at a year-end BOOST Science Symposium (Table 2).

Recruitment. BOOST Scholars apply to and are selected for the BOOST program between February and May of their 5th grade year from a series of feeder elementary schools in

Table 2. *BOOST Scholar Calendar. Timeline of BOOST activities from June - May.*

	Launch	Immersion Week	Science Saturday Prep	Science Saturday	Field Trip	Reflection	Science Symposium
June	x	x					
July			x				
August							
September			x	x	x	x	
October			x	x	x	x	
November			x	x	x	x	
December				x	x	x	
January			x	x	x	x	
February			x	x	x	x	
March			x	x	x	x	
April			x	x	x	x	
May			x			x	x

the Durham Public School system. The feeder schools have been recommended by the DPS science coordinator based on the percentage of students at that elementary school eligible for free and reduced lunch. Staff members and Coaches from the BOOST program conduct an in-person interview session with 5th graders who have been selected by their teachers as potential participants in the BOOST program. Here, students participate in a series of brain games with BOOST staff, Coaches, and fellow peers. Elements of the application process that are considered in the selection are teacher recommendations, student engagement during small group interviews, and general application materials. The expectation is that once selected, Scholars remain in the program for the duration of their middle school tenure. Each year, the average number of participants from URM groups is approximately 90.4% and the average number of students that are eligible for free and reduced lunch at their schools is approximately 64.7%. BOOST is also unique in that it is a gender balanced STEM program with, on average, 49.7% female-identifying and 50.3% male-identifying students participating every year.

Launch. Launch is the event that kickstarts the BOOST year. Launch takes place in early June and is the first time the Scholars meet their fellow cohort members, Coaches, and BOOST staff. At Launch, BOOST Coaches, alumni, and staff give brief presentations on program structure, program goals, and Scholar expectations. The entire calendar of events is presented here, which is important as it gives families ample time to plan how they will incorporate the BOOST Program into their yearly schedule. The unique aspect of this event is that each Scholar's entire family is invited to attend. Siblings gain exposure to what the program has to offer, encouraging them to apply when they reach middle school age. By including the Scholars' families in BOOST Launch, BOOST emphasizes the idea that the Scholars' success in the program is a team effort that includes not only support from BOOST Coaches and staff, but also support from home.

Immersion Week. Immersion Week is a one-week workshop held in June at DUSOM where Scholars first begin thinking about the scientific process through hands-on scientific experiments. Prior to the start of Immersion Week, DPS teachers meet with BOOST staff to develop a week-long curriculum for Scholars at each level of the program. The program is structured such that each day is divided into morning and afternoon sessions. In the morning sessions, the combined group of Scholars and teachers learn inquiry-based science pathways, gain new knowledge, and consider current problems or questions in science. In the afternoons, Scholars, Coaches, and teachers are grouped into three- to four-member teams. Each team is assigned a scientific problem and given the time, space, and resources to address their particular problem. Topics can include investigating the anatomy of the brain, evaluating animal behavior, and characterizing environmental ecosystems. Duke faculty from across the university, along with volunteer faculty from North Carolina Central University (NCCU) and instructors from the North Carolina School of Science and Math (NCSSM), provide guidance and serve as content experts to assist the teams in their daily projects. By placing Scholars in the role of co-learners with their teachers, Immersion Week fosters leadership, teamwork, communication, presentation skills, and confidence – necessary "success factors" for students to enter and succeed in higher levels of science education and professional training.

Key Program Elements. During the school year, the BOOST program engages its scholars through three main activities: individually mentored research projects, Science Saturdays, and field trips.

BOOST provides Scholars with an ongoing near-peer mentoring program that supports their science enrichment and inquiry. In a 4:1 Scholar/Coach ratio, participating Scholars work closely with a URM/DIS medical/graduate/undergraduate student Coach over the course of the school year on a research project of the Scholars' choosing. The first year of the BOOST program (6th grade) intensely focuses on what it means to be a scientist and more importantly, how to ask testable, hypothesis-driven, scientific questions. The goal within the first year of the program is to cultivate interest in science through immersion in various scientific topics. BOOST Coaches help their Scholars develop scientific projects and teach them the skills necessary to carry out a proper scientific experiment. Scholars will spend time investigating questions in the fields of biology, chemistry, and physics.

BOOST XL (7th grade) and XXL (8th grade) build upon the strengths cultivated through BOOST first year (6th grade), through program content increasing in sophistication and

ongoing development of core scientific inquiry skills. The two-year design of this segment of the continuum provides continuity through the remainder of middle school. The goal in the second (7th grade) and third year (8th grade) of the BOOST program is to broaden exposure and deepen interest within various scientific topic areas. BOOST XL and XXL years focus on sustaining URM/DIS students' engagement in science and developing skills – including verbal, written, analytical, and critical thinking – that will help them succeed in pre-collegiate sciences and, if they so desire, continue with higher education toward careers in STEM. Methods are consistent with those employed by BOOST 6th grade Scholars, featuring inquiry-based learning, experiential and hands-on activities, mentoring, and team-based research. The expectations for independence, communication, leadership, and effort are augmented commensurate with students' increasing maturity level and their development through BOOST participation.

Science Saturdays. Scholars meet with their Coach for eight half-day experiential learning opportunities called Science Saturdays throughout the academic year. Science Saturdays run from 10:00 a.m. until 2:00 p.m. at the DUSOM. BOOST Scholars work in cohorts with their Coaches and JCs on short-term hands-on projects that deepen their understanding of DPS science learning objectives. Some examples of the short-term projects include: creating an egg bungee jump to explore concepts related to physics, making a rainbow flame to understand chemical compounds, and learning how to measure vital signs in order to better understand anatomical principles. However, the main goal of each Science Saturday is for Scholars to work on their year-long research project. During the first Science Saturday, each squad identifies an area of scientific inquiry. During the second Science Saturday, each squad works together to propose a testable question regarding their area of interest. From there, each squad develops a series of experiments that can address their hypotheses. Throughout the rest of the year, each squad collects, analyzes and interprets the data relevant to their chosen project. This information is then packaged into a presentation that allows Scholars to concisely and accurately share their results with the greater BOOST community through the annual year-end BOOST Science Symposium. Some examples of year-long projects include: determining the effects of music on mood, measuring rate of decay on common fast food items consumed by middle school aged children, and understanding the impact of the environment on mental well-being.

Field Trips. In parallel with Science Saturdays, Scholars and Coaches travel as a group three times a year to engage in immersive STEM field trips. These experiences are carefully chosen to provide cohort-level appropriate material and align with the goals proposed for each BOOST grade level. BOOST leadership (Program Director, PIs, and Project Assistant) work with participating DPS teachers to ensure that the field trips support the content covered concurrently in their students' science curricula. At the BOOST level (6th grade), Scholars participate in field trips that emphasize how scientific questions are asked and how experiments are designed to answer scientific questions. At the BOOST XL (7th grade) and XXL (8th grade) level, Scholars participate in field trips that continue to address the scientific method but also address intricacies such as interpretation of data and dissemination of results. These field trips make use of Duke, Durham, and North Carolina facilities, BOOST faculty, and state-of-the-art technology to immerse the Scholars in novel science environments. These experiences expose Scholars to new scientific developments, concepts, information, and technologies. Scholars learn how problems that affect them or their communities are addressed through applied scientific and medical innovation. A major goal of research field trips is to show Scholars that they have a role in advancing science and technology. Planned destinations include the DUMC experimental surgery lab, genomics facility, hyperbaric chamber, free-electron laser, patient simulator, and autopsy labs; the Eno River Association, Krzyzewski Human Performance Lab (Coach K-Lab), Blue Jay Point, Trinity Center, and the NASA Goddard Visitor Center.

By the end of their participation in the BOOST program, students will have learned how to formulate good scientific questions, develop and carry out multiple science projects to completion, and present their work at multiple community science conferences. Scholars will develop a sense of self-efficacy and personal academic progress, possess commitment to their own goals and to those of the program and fellow Scholars, and demonstrate a growing interest in science. With Coaches' mentoring, Scholars learn to work productively in a team setting, participate in lab experiences, positively engage in the mentoring relationship, and confidently present their work.

Science Symposium. BOOST culminates each year in a Science Symposium. This event occurs at the end of May and is held in the Trent Semans Center at DUSOM. Here, Scholars from all three cohorts share the results of their group projects with fellow BOOST program Scholars, families, community partners, DPS staff, and DUSOM faculty. Each cohort has a designated time period in which they present their work. In this way, Scholars from other grade levels can see what their peers have been investigating throughout the course of the school year. Families are also major participants at this event and can interact with the Scholars to learn more about the science topics they have been exploring. This encourages siblings to join BOOST in future years. Some groups will also have hands-on activities that audience members

Figure 4. BOOST Program Timeline. In 5th grade, students are recruited to become BOOST program Scholars. In 8th grade, Scholars graduate from middle school and the BOOST program. In high school, Scholars have the opportunity to pursue further positions in the BOOST program, advancing from a JCiT, to a JC. When JCs graduate from high school, as undergraduate students they can apply for a position as a Coach.

can participate in. DPS and DUSOM community members will interact with the Scholars and ask questions about their scientific method, how their team arrived at their results, and what future directions or questions their findings may address. This event is crucial for the Scholars because it is one of the first times in their scientific careers that they will be disseminating their scientific work to others. Symposium serves as an important exercise in public speaking and science communication.

Beyond Middle School: Developing Leadership Skills through Near-Peer Mentoring. The BOOST Program is a longitudinal pathway program spanning elementary, middle, high school, into the collegiate and graduate school levels. It is integral to our program that our students have opportunities to stay invested in the BOOST community throughout their academic careers. Additionally, recruiting leaders for the program from the pool of students who have gone through the program themselves, allows students to benefit from the experiences of prior Scholars. Opportunities for continued BOOST leadership include Junior Coaches in Training (JCiTs), Junior Coaches (JCs), and Coaches (Figure 4).

Understanding that continuity is essential to long term benefits, BOOST provides Scholars with opportunities to stay in the program and lead their peers. First, Scholars can apply to be a JCiT. JCiTs are generally first-year or sophomore high school students who have recently graduated from the BOOST Scholars program. JCiTs work in squads with JCs and Coaches to lead Scholars through group activities. As juniors and seniors, JCiTs are able to move up the ladder and apply to become JCs. JCs are paid peer mentors who work with coaches to lead both JCiTs and Scholars through squad and cohort-level activities (Figure 4).

After high school, BOOST alumni have the opportunity to continue working with BOOST as a science Coach. Every year, BOOST recruits 25 undergraduate and graduate students to serve as BOOST Coaches. Graduate students range from medical students, to PhD candidates and postdoctoral fellows. Generally, Coaches are also underrepresented minority students in the sciences, placing Coaches in a unique position to share their experience and show Scholars the career possibilities they have available to them in STEM (Figure 4).

We know that leadership is a learned skill developed through education and practice. It is with that in mind that in

the past year BOOST has been developing a curriculum for our JCiTs, JCs, and Coaches around leadership. We hope to equip our staff with a leadership education they may practice as JCiTs, JCs, and Coaches, and ultimately apply to their future careers as leaders in STEM. For several years now, The DUSOM Feagin Leadership Program has been providing medical students, residents, and fellows with formal leadership education (K. L. Anderson et al., 2017). Their leadership model consists of five key concepts: emotional intelligence, teamwork, selfless service, integrity, and critical thinking. Feagin has been working with BOOST to adapt their leadership model for a high school and undergraduate level. The leadership curriculum will consist of seven sessions: Understanding Yourself, Emotional Intelligence, Selfless Service, Teamwork, Self-Advocacy, Career Development, and Financial Planning. Through active participation, BOOST leaders will develop transferable skills and engage in conversations that encourage further exploration of their personal leadership style. With a leadership curriculum in place, BOOST leaders will put their newly acquired leadership knowledge into practice as they lead their scholars through STEM related projects, field trips, and other BOOST related activities. Future research on program efficacy will evaluate the impact of this novel leadership curriculum to inform the continued growth of our program as well as provide scientific guidance for leadership education in other STEM pathway programs.

BOOST's Impact Overview. There have been over 600 middle school students that have engaged with BOOST since our inception. During the past 17 years, BOOST has been fully operational for 13 of those years averaging ~90 active scholars the past five years (Figure 4). We typically have >90% retention of scholars as they move from the BOOST (6th grade) cohort to XXL (8th grade) cohort. Around 50% of our XXL cohort join BOOST as junior coaches in training with around 80% of them going on to become junior coaches. We've had around 10% of our scholars eventually become coaches during some point in their educational journey. We measure our impact by the stories of our scholars from a young man that joined us as a scholar who went on to graduate from Columbia to another young woman who joined as a scholar who went on to graduate school. There are countless stories of how BOOST has changed the life trajectory for our participants and we are currently working on a full impact assessment report that we will share in the coming year.

CONCLUSION

To increase diversity in STEM, it is critical to increase early interest and retention in STEM among URM and DIS students. Here, we have described the background, principles, structure, timeline, and leadership of the BOOST Program at Duke University, a longitudinal pathway program designed to support URM and DIS students to become leaders in STEM. Working in partnership with the Durham Public School system, BOOST exemplifies why pathway programs must be in touch with their communities in order to best address the needs of the populations they serve. The BOOST program cultivates long-lasting interest and leadership skills in young students by combining near-peer mentoring with early intervention and opportunities for continuous program engagement. BOOST utilizes horizontal interactions such as near-peer mentorship to facilitate learning, ensuring that students develop critical leadership and scientific skills in parallel. By starting the program as early as 5th grade, BOOST provides an early intervention program, working against academic inequities established by lack of exposure to STEM education and resources that are evident as early as elementary school. By spanning "leaky" transitional periods between middle school, high school, and college, BOOST provides a stable, nurturing, continuous learning environment (Bøe et al., 2011). We believe that these components are synergistic, ultimately resulting in well-prepared students equipped with the leadership skills and scientific confidence to navigate a career in STEM.

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Author Contributions

The manuscript was written through contributions of all authors. All authors have given approval to the final version of the manuscript.

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ABBREVIATIONS

BOOST: Building Opportunities and Overtures in Science and Technology; Coach K-Lab: Krzyzewski Human Performance Lab; DIS: Disadvantaged Students; DPS: Durham Public School(s); DUSOM: Duke University School of Medicine; JCiTs: Junior Coaches in Training; JCs: Junior Coaches; NCCU: North Carolina Central University; NCSSM: North Carolina School of Science and Math; NSF: National Science Foundation; SEPA: Science Education Partnership Award; SSEP: Student STEM Enrichment Program; URMs: Under-represented Minorities

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