“It’s the Moon, Right?”: An Out of School Time, STEM Program Quality Improvement Project

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Table of Contents

Introduction

Each of the authors of this study came to higher education and the fields of science, technology, engineering, and math (STEM) in winding and obstacle-laden ways. We each recognize how difficult it can be to be first-generation college students, growing up in poverty, with parents who did not always know how to navigate the system, or without parents at all. We come to this work out of a natural-born desire to create and promote opportunities for children in minoritized communities. We see this work as a journey in social justice, as heart work, as much as an opportunity to improve the experiences of hundreds of students. This work is as much about giving back to the communities that have given so much to us, as fighting for future STEM experts to have greater access and opportunity.

The title of this study, “It’s the moon, right?,” is based on a comment from the director of our nonprofit partner organization. During an interview, we asked the supervisor “How many of the interns do you feel would be a good scientist, engineer, mathematician, or technology expert one day? (Why do you feel that way? What are some indicators you have seen?)” The supervisor responded “…these kids don't have anybody in their family or like, in college, it’s a stretch, Sounds like the moon, right?" (Supervisor, personal communication, August 5, 2022). This quote really defines the heart of our findings, if college is required to have a STEM career, and college is the moon, then how can these students become scientists, engineers, mathematicians, and technologists? A child must see that this work is relevant to them; they must see it as an option for them; in other words, they need to believe that it is more obtainable than the moon.

Area of Inquiry

The Partner Organization: SEEDS

This study will focus on a partnership with an organization called South Eastern Efforts Developing Sustainable Spaces, Inc (SEEDS). SEEDS was founded in 1994 in one inner-city community in Durham, North Carolina that had been defined as an "urban food desert" (SEEDS, 2022). The mission and objectives of the SEEDS organization is "to develop the capacity of young people to respect life, the earth, and each other through growing, cooking, and sharing food" (SEEDS, 2022). SEEDS achieves these objectives primarily through programming for community youth. In this study, we partner with SEEDS to evaluate the implementation of a pilot curriculum in the SEEDS program for high school students.

Defined as an "urban garden and kitchen classroom," SEEDS supports a variety of programs on food education and gardening that are child focused. Specifically, SEEDS supports four significant programs: SEEDlings (Elementary), SAPLINGS (Middle-school), Durham-Inner-city-Gardeners (DIG - High-school), and a summer camp program (ages 6 to 13). These programs, which SEEDS refers to as "edible education," were designed to support community youth engagement from ages 6 through 18, leveraging the main garden and buildings that house SEEDS program staff (SEEDS, 2022). Additionally, in summer of 2022, SEEDS piloted a STEM program called Microsoft's Azure FarmBeats (FarmBeats) in the DIG Program, which is the focus of this improvement study.

As a small non-profit organization, the staff at SEEDS is very limited. When fully staffed, the organization has at least seven full time positions which include the executive director, director of operations and administration, the farm manager and educator, the after school and summer camp coordinator, at least one chef educator, a farm educator and a coordinator of development and communications. The individuals in those positions are both stakeholders and participants in the research and their input is critical to a useful and accurate evaluation and set of recommendations. However, SEEDS currently has a lack of staff and does not have most of those positions filled, which led to the authors only interviewing two staff members - the acting

executive director (referred to as the supervisor) and the after school/summer camp coordinator, who was the instructor for the pilot program. The Farm Educator was also originally engaged in the study but did not ultimately participate.

Challenges at SEEDS

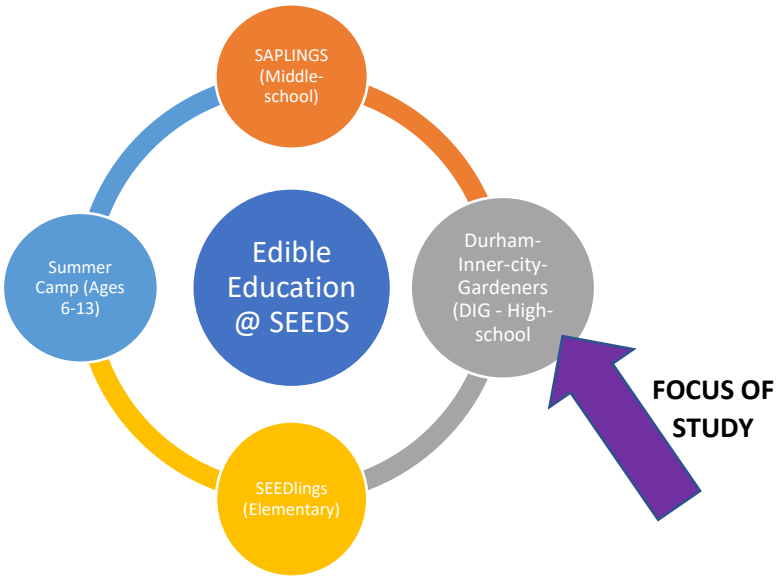
First and foremost, the challenges at SEEDS are an emerging issue. As a nonprofit organization serving a low-income community, resources are limited and the mission of the organization rests on their ability to reach and teach students. This mission became critical in the spring of 2020 when the COVID-19 pandemic prohibited in-person gatherings. The organization realized that they needed to adjust the way they deliver services, while also acknowledging the historic lack of infrastructure and participation in technology in low-income communities across this country. These are emerging issues in education, and therefore, the challenges are still new and not yet fully understood, providing what we believe is an opportune time to provide recommendations for improvement.

The organization has stated that it desires to improve access to technology for the underserved population of people in their community, while also cultivating technology skills related to agriculture in their current students (Supervisor, personal communication, December 10, 2021). Their constituents need access to technology due partly to the pandemic response to COVID-19 which pushed remote learning into the lowest level elementary and pre-school environments, but also because technology offers greater opportunity for individuals.

There is a strong body of research about the lack of participation in Science, Technology, Engineering, and Mathematics (STEM) fields from minoritized communities (Banerjee, 2017; Baran et al., 2019; Dou et al., 2019; Dou & Cian, 2022; Ferreira et al., 2015; Fry et al., 2021b; McGee et al., 2021; Tan et al., 2018) SEEDS views access to technology as a tool for addressing the lack of STEM resources in the community, while also expanding

their own programming. Students need the skills and knowledge of how to develop their interests and talents and turn them into successful careers. This is the strength of the multiple programs at SEEDS. Each program is designed to provide the much-needed technological resources and programming, in addition to age-appropriate STEM knowledge, that allows the organization to expand its reach. SEEDS remains challenged in determining whether they are meeting this goal, better ways to meet this goal and perhaps even strategies for virtual learning in their programs.

Figure 1: *SEEDs Programs*



This study will focus specifically on STEM in the DIG program. DIG participants are high school students who receive pay for working in the SEEDS garden. Often referred to as “DIG interns”, these students secure paid employment to begin creating a resume and building references which advantages them later in the job market. When SEEDS identified the Microsoft Azure FarmBeats for Students program, they were looking to use the experience to consider where and how STEM could be added to their existing programming (Supervisor,

personal communication, December 10, 2021). This study includes an evaluation of the pilot FarmBeats program as implemented in the DIG Program.

This program, and the work of increasing access and opportunity in STEM for minoritized students, is necessary, at least in part, because there is an acknowledged technology literacy gap in inner-city communities where access to technology is not as commonplace as more affluent suburban communities (Ferreira et al., 2015; OECD, 2006; Visser & Hong, 2017; Watkins, 2018). Indeed, some researchers suggest we are amid a 4th industrial revolution due to the rapid advances in technology (Kodama, 2018). If this is the case, those without the skills, access, and opportunity to engage in STEM fields will be left even further behind. Furthermore, the National Science Foundation (NSF) has stated it is an "economic imperative" for the U.S. to invest in building and supporting growth in producing a workforce focused on innovation in STEM fields" (Beering et al., 2010). As a nation, we must prepare to compete in the global economy and that means recognizing the emerging and growing STEM industry needs. As fighters of social justice, we must ensure those opportunities are afforded to all our citizens, regardless of race or zip code.

However, data indicates that there is still a persistent and deep inequity wherein the largest number of career participants in the STEM fields continue to be white males (Fry et al., 2021a). One reason for this inequity, according to McGee et al. (2021), is that scientific research in the United States has historically portrayed Black people as biologically and intellectually inferior to whites, a framing reified in STEM education.

One of the major recommendations from the National Science Foundation (NSF) and other researchers for improving access and opportunities in STEM in minoritized communities is to ensure early intervention in STEM learning (Baran et al., 2019; (Beering et al., 2010); Estrada et al., 2018; Nava & Park, 2021; Sondergeld et al., 2016). It is imperative that programs are designed to encourage under-represented minoritized participants into STEM education and career pathways. Research has also shown that community-led programs that connect STEM to underserved youth can positively impact the problem of inequitable representation (Baran et al., 2019;

Burg et al., 2016; Collins & Halverson, 2010; Steiner et al., 2019; Tan et al., 2018). This is the meeting place of this work and the current literature.

There is a defined need in the community within which our partner organization is situated to improve the STEM opportunity and access gap. SEEDS' power as a community organization can be leveraged to not only meet the goals of the organization, but also the social justice goals of the community. The multiple programs are the vehicles by which SEEDS does this work. This evaluation focused on the high school DIG program, just one of SEEDS' vehicles for change, and sought to determine future programming that incorporates more STEM activities. Later studies may look at other programs offered by SEEDS or other activities in the DIG program. Yet, this study also aimed to identify ways SEEDS may sustain the work in the long term and includes recommendations for the overall direction of the organization, which could impact any of the programs within SEEDS.

As noted above, and like many after school programs, SEEDS was impacted by the COVID-19 pandemic (C. Polanco, personal communication, October 23, 2020). SEEDS had already been looking at improving the career skills available for the DIG interns with programming that complements their edible education goals when COVID-19 uncovered a wide gap in technology skills for their interns (Supervisor, personal communication, November 19, 2021). This gap in STEM infrastructure/technology and STEM knowledge, coupled with the potential absence of STEM skills in the community, has exacerbated an already growing gap in technology access for the students.

In preliminary conversations, SEEDS' staff expressed an interest and identified resources to develop and support introducing more STEM learning into their programs. SEEDS' staff envision themselves as community leaders in providing STEM learning opportunities and events. Yet, SEEDS has not done any work toward addressing the area of STEM learning beyond providing basic technology tutoring to support remote learning needs – like how to use Zoom – during after-school programming and early in the pandemic when all onsite operations were suspended. Their programs are designed to expand students' blossoming skills that have begun

to develop and help them meet proficiency. The goal is to not just provide technology skills, but also to educate students on how technology can be applied in modern day agriculture and engineering. SEEDS' programs provide an opportunity to help these students develop innovative and futuristic skills that will not only bridge the gap between students' current technology skills and their peers but position them for future success.

As a nonprofit organization, SEEDS has limited funds and resources and is hesitant to invest in adding STEM into programming or introducing new community STEM programs without having support and recommendations on what proven practices exist to help ensure successful STEM efforts. For this reason, they partnered with us to evaluate the FarmBeats pilot in the DIG program in Summer 2022 and provide recommendations on whether they should expand the existing programs and if any program additions would ultimately further SEEDS' mission.

Evidence and Assumptions

SEEDS had only observational and anecdotal data to provide an assessment about the technology aptitude of the participants in the programs. There had been no data collected or needs assessment done beyond general discussions among staff and the Board that adding in some technology training and learning would be helpful. There is a bit of an organizational assumption that the intervention would be beneficial (Supervisor, personal communication, November 19, 2021). This assumption led to the decision to focus on the high school students as they are most likely to benefit as they are considering their future careers in the next couple of years. After discussions with SEEDS staff, it also seemed to be the easiest place to begin to bridge the technology gap, provide technology literacy and access, and teach the students how agriculture has progressed into using technology (Supervisor, personal communication, November 19, 2021).

Key Constituents

SEEDS has a variety of potential engaged parties that could be involved and would benefit SEEDS as an organization as well as the community which includes the underserved population that SEEDS is focused on assisting. Here is a summary list of constituents:

Table 1

SEEDS Constituents

Community/Group	Description
Local residents – gardeners	Volunteer gardeners and interested neighbors
Volunteers	Volunteers for fundraising events or ad-hoc efforts for gardening or support
DIG Interns	High school students in the DIG program that are also paid staff
Donors	Corporate and private citizens donations
After-school students/families	Families supported with after-school activities – SEEDlings/SAPLINGS, and DIG
SEED staff	Staff paid to run and manage the non-profit programs and ongoing operations
SEEDS Board members	Board of directors that serve on a volunteer basis and often support programs or fundraising efforts

In addition to the important work of addressing the lack of STEM initiatives in this community and assisting the organization in furthering its mission, this study also informs new investment areas for existing SEEDS programming. As a non-profit organization, SEEDS is in constant need of those willing to dedicate time and resources to important work. The findings may include STEM learning and training that would inform new community programs around STEM. This study will also provide data to inform decisions on whether to fully implement and sustain individual elements of the DIG program. Finally, SEEDS staff will use this information to direct fundraising decisions and the pursuit of relevant grants considering program budgets do not have much room to absorb additional costs.

Introducing STEM at SEEDS

SEEDS wanted to evaluate programming additions for STEM that can be quickly piloted with a low cost and high potential impact (Supervisor, personal communication, November 19, 2021). As noted, the Microsoft Azure FarmBeats program combines technology with curricula and specific activities which are meant to give students real world experience in "applying precision agriculture techniques to food production" (Microsoft, 2022). The program provides the technology and the pedagogy to teach students how technology is integrated into farming and agriculture. The curriculum and script include activities where students set up various technology tools and others where they work with data gleaned from the tools they built. "The learning progression enables students to easily see the connections between these modern agriculture tools and the opportunities they afford" (Microsoft, 2022).

This study includes a program evaluation of the FarmBeats program as administered in the summer of 2022 in the DIG program. The institutional hypothesis is that community- led STEM access will lead to improved engagement in STEM topics outside of school for underserved youth populations, which will lead to a greater likelihood of pursuing STEM subjects and instruction in their schools (Supervisor, personal communication, December 10, 2021).

Research Synthesis

Areas of Research

This research synthesis primarily aims to summarize the value and impact of creating science, technology, engineering, and mathematics (STEM) learning opportunities at our partner organization, SEEDS. We also summarize what is needed to effectively implement STEM programming by reviewing their piloting of a proven STEM student engagement program.

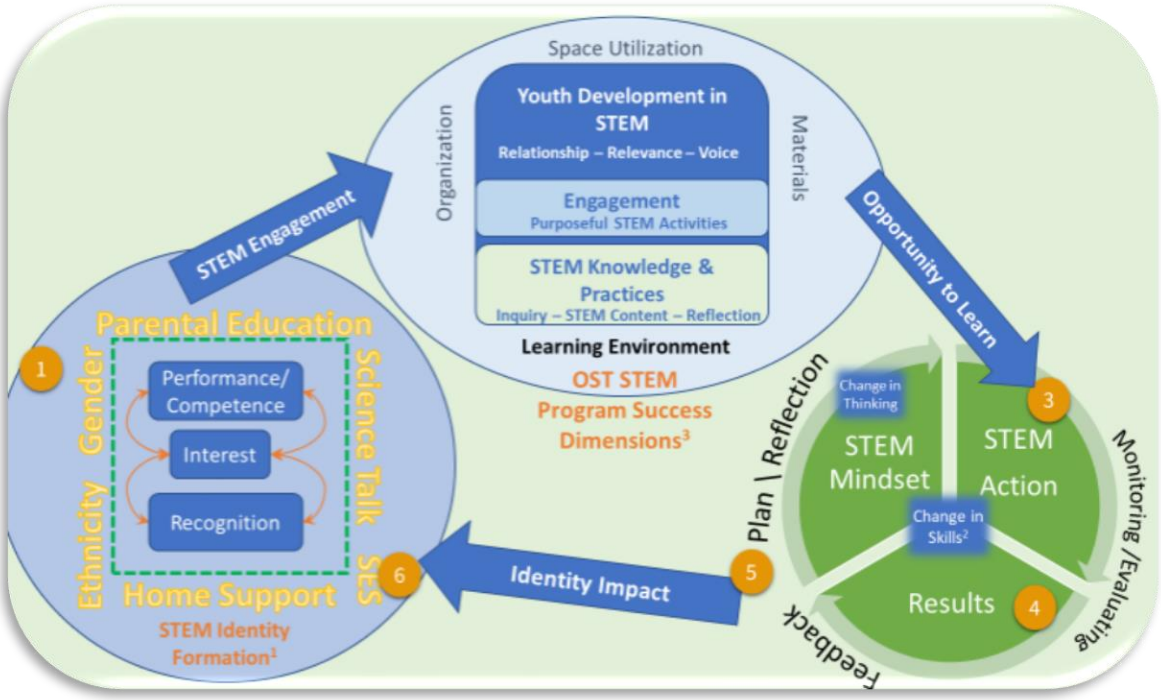
After reviewing SEEDS' needs and goals, we developed three study questions we believe are central to established research in the field and were used to guide our collaborative study with SEEDS regarding STEM engagement and improved access for underserved communities. The three study questions also guided our discovery of the five buckets of literature to be consulted. The three study questions are:

1. Are community-led programs focused on improving access and engagement with STEM topics helpful for the underserved population that SEEDS supports?
2. Will the availability of high-quality STEM curricular resources and technology support enable a community organization to improve access and engagement with STEM topics from an underserved youth population?
3. Will SEEDS interns show deeper interest in STEM after the pilot program? Are community STEM needs met by implementing community-led programs focused on improving access and engagement with STEM topics for the underserved youth population that it supports?

The Research Synthesis is not an exhaustive list of what community-led programs need to know; however, our goal is to evaluate STEM programming, and help document its impact on the intended, with an

aim of enabling improvement at the K-12 level. A high-level conceptualization of how the existing research supports the elements of this study is shown below.

Figure 2: *Study Conceptualization*



This conceptualization begins with the development of STEM identity (the orange number one on the left side). STEM identity is impacted by various elements including, but not limited to, the students' ethnicity and gender, their parents' education levels, their own interests, performance in STEM areas, and the support they receive at home (Dou & Cian, 2022). As we look at how to intentionally develop students' STEM identity, we move to the elements of Out of School Time STEM Program Dimensions of Success (orange circle 2) which include features of the learning environment, activity engagement, STEM knowledge and practices, and youth development in STEM (Shah et al., 2017). Observing these elements and analyzing the dimensions of success, we examine the students' opportunities to learn (orange circle 3) which include whether the learning impacted the students' mindsets about STEM, improved their skills in STEM, and/or impacted their

own identity around STEM (Cheng, 2019). By engaging students in STEM and providing meaningful opportunities to learn, we can impact their STEM identity and help them to see themselves in this work (orange circle 4; Cheng, 2019).

Each experience, exposure, and engagement with STEM lends another brick to the foundation of the individual student's identity and the more times they participate and engage in STEM, as seen by the circular nature of this graphic, the more likely their own perceptions of STEM will positively increase (Dou & Cian, 2022).

As we developed the conceptualization, we determined five areas of study that were relevant to this work. Although there is some overlap in the areas of the literature, these five research areas supported this study: *Community Led Programs and Underserved Communities, High-Quality STEM Curricular Resources, Internships and STEM Access Improvements, Foundational Learning Theory, and Equity in Research and Community*.

Community-Led Programs and Underserved Communities

Related Research Question: Are community-led programs focused on improving access and engagement with STEM topics helpful for the underserved population that SEEDS supports?

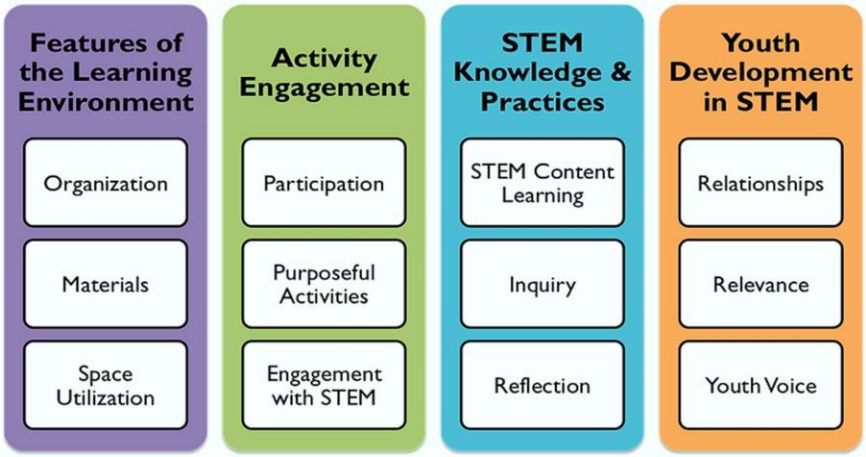
STEM identity is an individual's label of a STEM persona. STEM values and standards are reflected in that recognition often associated with "white masculinity" (Dou & Cian, 2022). Determining one's identity is a self-reflexive process in that one can classify or name one's own identity in particular ways in relation to other societal designations (poor, rich, middle class, white, Black, Asian, etc.), and importantly, one can redefine their identity and it can be self-actuated (Burke & Rotermund, 2021). As described above (see Figure 2), many things can impact a student's initial STEM identity. For example, science talk at home can contribute

to STEM identity (Dou and Cian, 2022). Still, we know we need to do more, including changing the narrative of racial and gender exclusion (Watkins, 2018). A new narrative can lead to a positive shift in STEM identity within underserved communities if there is an opportunity for people to experience shifts in their STEM identities (Estrada et al., 2018). There are several models of success that SEEDS can consider for creating positive community impact in STEM education this way.

Among the best sources to evaluate identity formation models is the Center for Advancement of Informal Science Education (CAISE, 2022) which is funded by the US National Science Foundation (NSF) and is replete with successful programs (Bell et al., 2016). The Faculty Early Career Development (CAREER) program is designed to help faculty members that are early in their career serve as academic role models. Early-Concept Grants for Exploratory Research (EAGER) work in exploratory areas and recently investigated barriers to and strategies to increase Historically Black Colleges and Universities (HBCU) participation in STEM education research (Trawick et al., 2022). Other programs like LA's BEST (Better Educating Students for Tomorrow) focus on safe recreational activities, for more than 18,000 students (Geiger & Britsch, 2018). Each of these programs developed elements that are compatible with the SEEDS goal of improving student STEM identity, access, and opportunity.

Another tool for SEEDS to consider and that was used in this study is the Dimensions of Success (DoS) framework (Shah et al., 2017). This framework was developed by the PEAR Institute (Partnerships in Education & Resilience), an interesting public/private partnership started at Harvard University to reduce inequity in community. The DoS framework was created from research on 77 different Out of School Time (OST) programs that took place during the school year and through summer breaks (Shah et al., 2017). The study team used an adapted version of these dimensions to create an observation protocol (See *Observation Protocol* in Appendix B). A snapshot of the DoS framework to support high-quality OST STEM initiatives is shown in Figure 3 as follows.

Figure 3*: Dimensions of Success Framework*
Source: Shah et al., 2017



High Quality STEM Curricular Resources

Related Research Question: Will the availability of high-quality STEM curricular resources and technology support enable a community organization to improve access and engagement with STEM topics from an underserved youth population?"

This question can be addressed through literature about high quality STEM curricular resources. Over the past two decades STEM has been a focal point for the United States (Martin & Fisher-Ari, 2021). If community-led programs like LA BEST, and EAGER can be replicated to diverse communities, evidence supports the positive mental shift in STEM identities. Research implications show the importance of faculty that is trained and intentional, with an intersectional lens regarding race, gender, and the ideologies of who and what is considered STEM (Martin & Fisher-Ari, 2021).

The curricular resources available for the SEEDS pilot provided by Microsoft offer a guiding structure for the STEM topics to be introduced at SEEDS. A summary of the program is shown below:

Figure 4: *SEEDS STEM Pilot Overview*

With attention to the DoS Framework to model an OST pilot, in conjunction with proven curricular resources, SEEDS had an opportunity to implement and evaluate this core question through the piloting of the FarmBeats curriculum. Although SEEDS did use the FarmBeats curriculum, they did not follow the curriculum timeline exactly, instead the study authors worked with them to modify the timeline to deliver the program in 3 weeks, doubling up on lessons in a day. This will be discussed further in limitations, but as we discuss the implementation of the program, we want to be transparent in the changes that were made. That modified timeline is available in Appendix A.

Internships and STEM Access Improvements

Related Research Questions: Will SEEDS interns show a deeper interest in STEM after a project?" and are community STEM needs met by implementing community-led programs focused on improving access and engagement with STEM topics for the underserved youth population that it supports?"

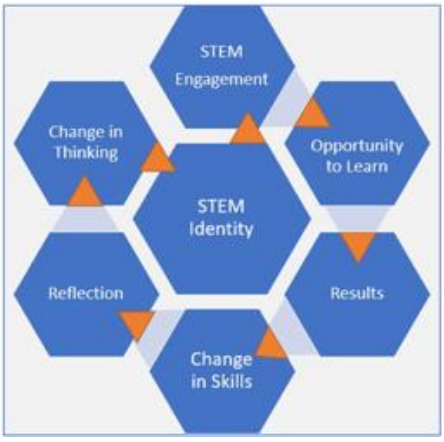
These questions were designed to understand how students' interests and the community interest in STEM may be impacted by the available programming. Student's career interests and intentions may be reinforced by their participation in STEM internships (Martin and Fisher-Ari, 2022). We delved deeper into this area of the literature to determine potential impacts for the DIG interns participating in the pilot.

Importantly, STEM interventions and STEM persistence were some of the key experiences aided in the reinforcement of student STEM identities (Dou & Cian, 2022). Furthermore, a separate set of research studies identified that positive STEM identity is a predictor of pursuing a STEM major (Wang, 2013) and ultimately a STEM career (Dou et al., 2019).

While the body of literature is relatively new regarding Outside of School Time (OST) and STEM, there are examples of positive impact of OST STEM participation (Bell et al., 2016; Geiger & Britsch, 2018; Shah et al., 2018). More specifically, their research indicates that investments in informal STEM education have resulted in a large growth in the variety of resources and depths of expertise (Bell et. al., 2016). Our belief is that incorporating STEM topics for implementation into SEEDS programming may help bridge the gap in STEM careers for those that have been historically disenfranchised.

A visual overview below, starting with a central STEM identity, serves as an illustration of the theory of change to be observed in the SEEDS STEM Pilot:

Figure 5: *SEEDS STEM Pilot Theory of Change*
Source: Adapted from Cheng, 2019



As Figure 5 indicates, if we begin in the middle with a focus on STEM identity and we follow the arrows we see the elements of developing that STEM identity. Students must be engaged in STEM, have opportunities to learn, find results in the work, change their skills based on these experiences, reflect upon that practice so that it becomes a part of their identity, leading to a change in their thinking about STEM and hopefully deepening their own STEM identity. The process is circular in that developing one's identity will continue to develop over the course of one's life. Identity making is a lifelong journey.

Foundational Learning Theory

Scribner (1986) Saxe (1988) indicate it is important to look at learning as participation and encourage us to deeply consider the practice of learning activities in action, as well as the socio-cultural context of learning environments and the inextricable impact on both the learner and learning goals. Lave and Wenger (1991) put forth legitimate peripheral participation (LPP) as critical to understand a framework for learning activities within the communities where learning takes place and provide further refinement to understanding situated learning. They describe LPP as a structure allowing analysis and discussion of how "the mastery of knowledge and skill requires newcomers to move toward full participation in the sociocultural practices of a community" (Lave & Wenger, 1991, p. 29).

Furthermore, Lave and Wenger (1991) counsel for the need to consider LPP in learning design and assessment. Greeno and Gresalfi (2008) expand upon that to identify how opportunities to learn (OTL) dictate the complex contextual continuum that influences an individual's move toward full participation in a community of practice (CoP). They describe the need to consider OTL observed within an activity system, which is defined as: "one or more persons interacting with each other and with material and informational resources that are present in the setting" (Greeno & Gresalfi, 2008, p.170). As we define discrete opportunities for learning, we must consider affordances and constraints as Greeno and Gresalfi (2008) point out in comparing trajectory of an

object in motion with the process of learning and the learning journey of either an individual or a group. This literature further supports the use of the DoS framework since it also specifically looks at the opportunities to learn in the STEM OST program.

Trajectory is also discussed by Nespor (2006) as part of the evolution of description needed for sense making with observational field notes that serve as a cornerstone of social science research. Nespor (2006) states: “You treat what you're observing as relationally constituted and foreground events, interactions, transactions, flows, and relations” (p. 298). In other words, the researchers must become immersed in the activity system they are looking to describe. Additionally, Nespor (2006) offers guidance on field note techniques to look for patterns to consider what context is at play as we look to collect data. This literature was critical in developing our own data collection and analysis processes.

Combining the work of these scholars, the current researchers observed the learning taking place based on formal observations and then analyzed patterns found within the bounded site described. Based on the data observed, analysis and suggestions for design improvements are offered as aligned with this theoretical framework.

Equity in Research & Community

The final area of literature that informs and guides this project is found in the idea of equity in research and community. This means that the researchers try to provide reciprocity in the research process and avoid exploitation of the organization. This is a primary ethical issue for the study authors. As practitioners ourselves, it is important to us that our study is participatory, while also allowing us enough access to information that we may provide learnings and support to ensure the project is meaningful for all involved. This will require a focus on humanizing our research, including stakeholders and participants, throughout the project, and ensuring our

findings and recommendations are relevant and meaningful to those most impacted by the program. The authors of this study provided sweat equity in volunteering with the students and organization in the gardens, the classroom, and the kitchen. These volunteer experiences were separate from the actual study and were performed before the study commenced. This connection humanized the authors to the SEEDS staff and the DIG participants, but also modeled the authors' goal to provide reciprocity in the work.

One framing that reflects this ethical concern is what Barnett and Camfield (2016) define as the "*right for inclusion"* when determining which constituents have a voice in research project evaluation structure and process (p.6). This *right for inclusion* is a key concern when program participants are youth, yet impact and evaluation processes are in the hands of adult community members, Vanderbilt researchers, and the SEEDS staff. We discussed this ethical concern and consistently kept the students' interests in mind. We had a moving and unexpected experience at the end of the second observation where the students organically engaged with us. They asked us about our own journeys in higher education and we shared our experiences. This organic experience provided us the opportunity to provide some reciprocity in the research and humanize ourselves to the students.

A second ethical consideration is how to engage in any improvement project for an underserved community without furthering what Cole calls the *white savior industrial complex* (as cited in Aronson, 2018, p.36). As doctoral students, coming from a predominantly white institution, we must be aware of our presentation and our role in the research and in the community. Careful crafting and modeling of the research project and processes both before, during, and after the research project helped to address these concerns. We also addressed this concern by partnering with the organization's staff and listening to their concerns and needs to build into the recommendations.

As we worked to humanize our research with an equity lens, which fits cultural study suggestions in humanizing research, we modeled our work on the research of da Silva Iddings (2018) who advocates exploring

and mapping the *sociocultural ecology* in diverse communities. She notes that it is imperative to describe the current state and needs of the organization as well as to model how policy suggestions may impact the future state (Da Silva Iddings, 2018). This means that in developing the recommendations, we were sensitive to the intricacies of the SEEDS community and the communities' needs.

Another humanizing strategy, suggested by Irizarry and Brown (as cited in Paris & Winn, 2014, Ch. 4), is in how to model *Participatory Action Research* with youth of color in urban settings that would move our project team out of a "team of researchers" paradigm and more into alignment with the participant community. By volunteering and working alongside the staff and students, we helped to build the relationships required to be partners and not outsiders.

Beyond research, in modeling interventions or change, Costanza-Chock (2020) defines a set of *Design Justice Principles* which seek to guide conscientious practitioners towards a more holistic approach in an improvement study design that is also appropriate for rigorous research processes and impact evaluation. This literature was critical to our recommendations in demonstrating successful methods. Specifically, Recommendation #1, that SEEDs should design a cultural audit and a collaborative review of the cultural audit survey with the organization and the community constituents. This suggestion is directly aligned to Costanza-Chock's *Design Justice Principle* #2 to "center the voices of those who are directly impacted" (Costanza-Chock, 2020, p.6).

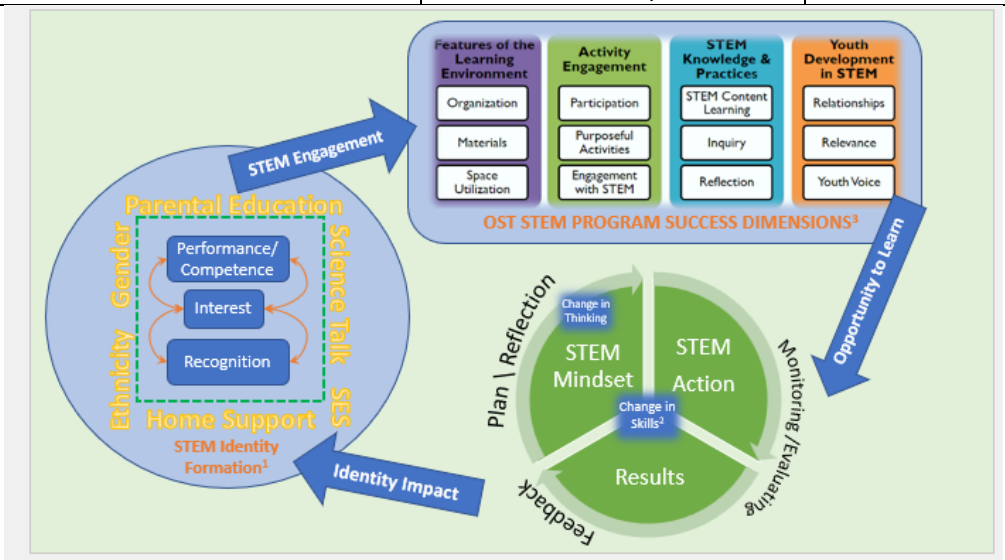
A further example, aligned with this same principle, is the recommendation to apply open data access and transparency, as suggested in Barnett and Camfield (2016), to any research project with SEEDS. In this manner the research project structure and processes can engage the community served as well as serving the needs of the institution and researchers. This structure would make future participatory research more efficient and inclusive.

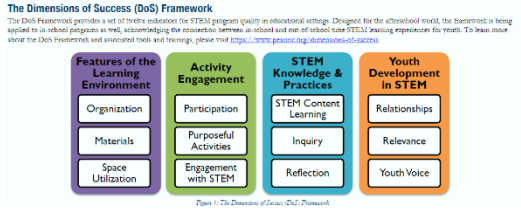
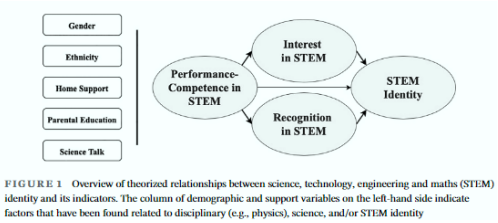
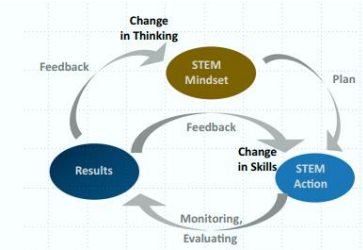
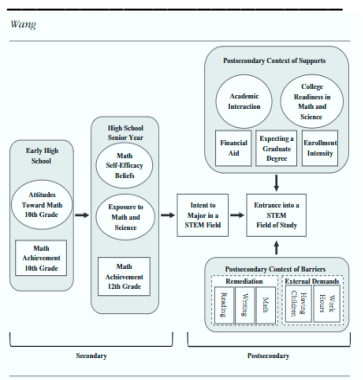
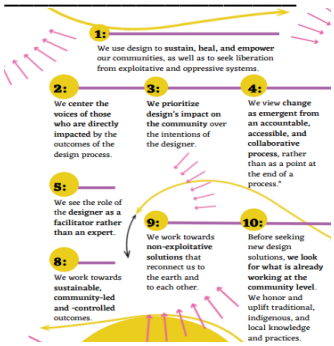
Keeping the ethical concerns and mitigation approaches in mind, we worked to balance equity and humane research. Ideally, we wanted to focus on aiding SEEDS in improving their positive impact in an environment where the focus is supporting underserved constituents and continue in refining its place in the broader Durham community.

Data Collection and Analysis Report

In keeping with our own ethical principles, it is imperative that we are transparent about the data collected and the process of analysis that led to our findings and recommendations. To that end, this section of the report explains the data that was collected and why and explains how the data was analyzed. The project map (Figure 6) below provides a high-level overview of all the sections of our data collection and analysis. A more detailed explanation of each follows the map.

Figure 6*: Project Map*

SEEDS wants to be able to:	Evaluate the impact of the students' STEM learning opportunities within existing program activities.	Implement effective STEM programming by piloting a proven student engagement STEM oriented program (i.e. AZURE FarmBeats)	Bridge the gap for minoritized students in STEM by teaching them resiliency and life skills.
Conceptual Framework			

Frameworks for each Question	**Out of School Time (OST) program evaluation -OST (or early engagement) will help define/improve STEM Identity**  The Dimensions of Success (DoS) Framework The DoS Framework provides a set of twelve indicators for STEM program quality in educational settings. Designed for the afterschool world, the framework is being applied to in-school programs as well, acknowledging the connection between in-school and out-of-school time STEM learning experiences for youth. To learn more about the DoS Framework and associated tools and trainings, please visit https://www.pearweb.org/dimensions-of-success Features of the Learning Environment: Organization; Materials; Space Utilization Activity Engagement: Participation; Purposeful Activities; Engagement with STEM STEM Knowledge & Practices: STEM Content Learning; Inquiry; Reflection Youth Development in STEM: Relationships; Relevance; Youth Voice Figure 1: The Dimensions of Success (DoS) Framework  Gender; Ethnicity; Home Support; Parental Education; Science Talk Performance-Competence in STEM Interest in STEM Recognition in STEM STEM Identity FIGURE 1 Overview of theorized relationships between science, technology, engineering and maths (STEM) identity and its indicators. The column of demographic and support variables on the left-hand side indicate factors that have been found related to disciplinary (e.g., physics), science, and/or STEM identity Identity Construction in STEM	**OST Opportunity to Learn**  Change in Thinking; Feedback; STEM Mindset; Plan; Feedback; Change in Skills; Results; STEM Action; Monitoring, Evaluating **Source(s)**: Adapted from Cheng (2019, ch.3)  Wang Early High School; Attitudes Toward Math 10th Grade; Math Achievement 10th Grade High School Senior Year; Math Self Efficacy Beliefs; Exposure to Math and Science; Math Achievement 12th Grade Intent to Major in a STEM Field Entrance into a STEM Field of Study Postsecondary Context of Supports; Academic Interaction; College Readiness in Math and Science; Financial Aid; Expecting a Graduate Degree; Enrollment Intensity Postsecondary Context of Barriers; Remediation; External Demands Secondary; Postsecondary *Figure 1.* Theoretical model for the study. What impacts STEM Major Choice?	**Social Justice Standards Design Justice Principles**  Identity; Diversity; Justice; Action  1: We use design to sustain, heal, and empower our communities, as well as to seek liberation from exploitative and oppressive systems. 2: We center the voices of those who are directly impacted by the outcomes of the design process. 3: We prioritize design's impact on the community over the intentions of the designer. 4: We view change as emergent from an accountable, accessible, and collaborative process, rather than as a point at the end of a process." 5: We see the role of the designer as a facilitator rather than an expert. 8: We work towards sustainable, community-led and -controlled outcomes. 9: We work towards non-exploitative solutions that reconnect us to the earth and to each other. 10: Before seeking new design solutions, we look for what is already working at the community level. We honor and uplift traditional, indigenous, and local knowledge and practices. Design Justice Network
STUDY Questions	(1) Are community-led programs (SEEDS-DIG) focused on improving access and engagement with STEM topics helpful for the underserved youth population that SEEDS supports? What is the impact of community-led programs like SEEDS on improving access and engagement in STEM for the underserved students that SEEDS support?	(2) Will the availability of high-quality STEM curricular resources and technology support enable a community organization (SEEDS) to improve access and engagement with STEM topics for an underserved youth population?	(3) Will DIG interns show deeper interest in STEM after the project? Are community STEM needs met by implementing a community-led program focused on improving access and engagement with STEM topics for the underserved youth population that SEEDS supports?

Methods & Explanation	• Document Analysis, Observation, & Interviews • This question gets to the program evaluation of SEEDS' DIG program overall- we will analyze SEEDS documentation and organizational data and observations as part of our data collection. We are also looking for an appropriate measure of community engagement	• Observation & Interviews • This question addresses the piloting of Microsoft's Azure FarmBeats program- all administration of survey data will be done by SEEDS staff. We will use this data, along with observations and staff interviews to respond to this research question.	• Post-activity Interviews • Observations/Field Notes • This question is meant to address the social justice issues around minoritized communities and STEM. This will be done with pre and post program activity interviews with SEEDS staff conduct
Tools	• Observation Protocol #1 • Interview Protocol Q#2, Pre • Interview Protocol Q#3, Pre	• Observation Protocol #2 • Interview Protocol Q#2, pre and post questions	• Observation Protocol #3 • Interview Protocol Q#3, Post • Interview Protocol Q#3, Post
Hypothesis	The students engaged in SEEDS activities find value in STEM learning which meets a community need.	The DIG programming, including Azure FarmBeats is a good fit for SEEDS.	DIG Students explore STEM fields after graduation.
Findings (THEME)	1. SEEDS' organizational STEM identity is underdeveloped which limits the organization's ability to meet the STEM needs in the community. (Community) 2. Negative self-reported Instructor and Supervisor STEM identity may inadvertently reinforce misplaced stereotypes, and perpetuate low expectations for youth participants (STEM Identity)	3. With reduced STEM acumen in the instructor, we saw a decrease in the depth of instruction for the students. (STEM Acumen) 4. Delivery was impacted when non-STEM instructors lacked STEM knowledge. While the curriculum was designed for non-stem instructors, delivery was impacted by the instructor's lack of context knowledge to make connections. (Curriculum)	5. STEM identity of students showed positive change both as self-reported and observed in post-pilot data collection (Relatable) *Negative self-reported Instructor and Supervisor STEM identity may inadvertently reinforce misplaced stereotypes, and perpetuate low expectations for youth participants (STEM Identity)*

Recommendations	1. SEEDs should design a cultural audit and a collaborative review of the cultural audit survey with the organization and the community constituents. 2. SEEDS should apply open data access and transparency to any research project with SEEDS to engage the community served.	3. SEEDs should adopt the Microsoft Azure FarmBeats curriculum, or something similar, in their DIG program to increase student STEM identity 4. STEM programs should be taught by those with STEM backgrounds when student STEM backgrounds are weak.	5. SEEDS should partner with the local school system to align STEM activities with grade level skills 6. SEEDS should provide more exposure to minorities in STEM

Study Questions

This study was designed around the three research questions (each with multiple parts) that were originally discussed above when we introduced our areas of research.

1. Are community-led programs (SEEDS- DIG) focused on improving access and engagement with STEM topics helpful for the underserved youth population that SEEDS supports? What is the impact of community-led programs like SEEDS on improving access and engagement in STEM for the underserved students that SEEDS support? This question gets to the program evaluation of SEEDS' DIG program overall- we analyzed SEEDS documentation and organizational data and then included our own observations as part of our data collection. We were also looking for an appropriate measure of community engagement as we explored the literature and the data.
2. Will the availability of high-quality STEM curricular resources and technology support enable a community organization (SEEDS) to improve access and engagement with STEM topics for an underserved youth population addresses the piloting of the FarmBeats program? Most of this data came from our three observations and interviews with the supervisor and instructor.
3. Will DIG interns show deeper interest in STEM after the project? Are community STEM needs met by implementing a community-led program focused on improving access and engagement

with STEM topics for the underserved youth population that SEEDS supports? This question is meant to address social justice issues around minoritized communities and STEM. This question was analyzed with data from the pre and post program activity interviews with SEEDS staff.

Data Collection Instruments and Tools

The authors conducted three formal observations of the pilot FarmBeats program- two in person and the third virtually. All observations were conducted using an observation tool designed by the PEAR Institute (Partnerships in Education & Resilience), a partnership at Harvard University to reduce inequity in community (Shah et al., 2017). Although designed to measure STEM engagement in out of school time programs, the observation protocol was adapted to meet the needs of the study authors. As explained in the research synthesis, the four dimensions of success (features of the learning environment, activity engagement, STEM knowledge and practices, and youth development in STEM) and twelve domains of the DoS framework (organization, materials, space utilization, participation, purposeful activities, engagement in STEM, STEM content learning, inquiry, reflection, relationships, relevance, and youth voice) allowed a comprehensive review of the classroom, the teacher, the actual learning, and the impact on the students. This observation tool can be found in Appendix B.

We also conducted four total interviews. Two before the pilot, one each with the instructor and supervisor, and two after the pilot with the same two individuals. The interview protocols were developed using the research questions and the appropriate literature. Specifically, we incorporated the tenets of humanizing and participatory research using the principles of design justice (Paris & Winn, 2014; Costanza-Chock, 2020). The literature around STEM identity made it clear that it was possible that the right out of school time STEM program can improve student STEM identity (Burke & Rotermund, 2021; Dou & Cian, 2022). As we were not directly interviewing students, it was imperative that we ask the appropriate questions before and after the pilot

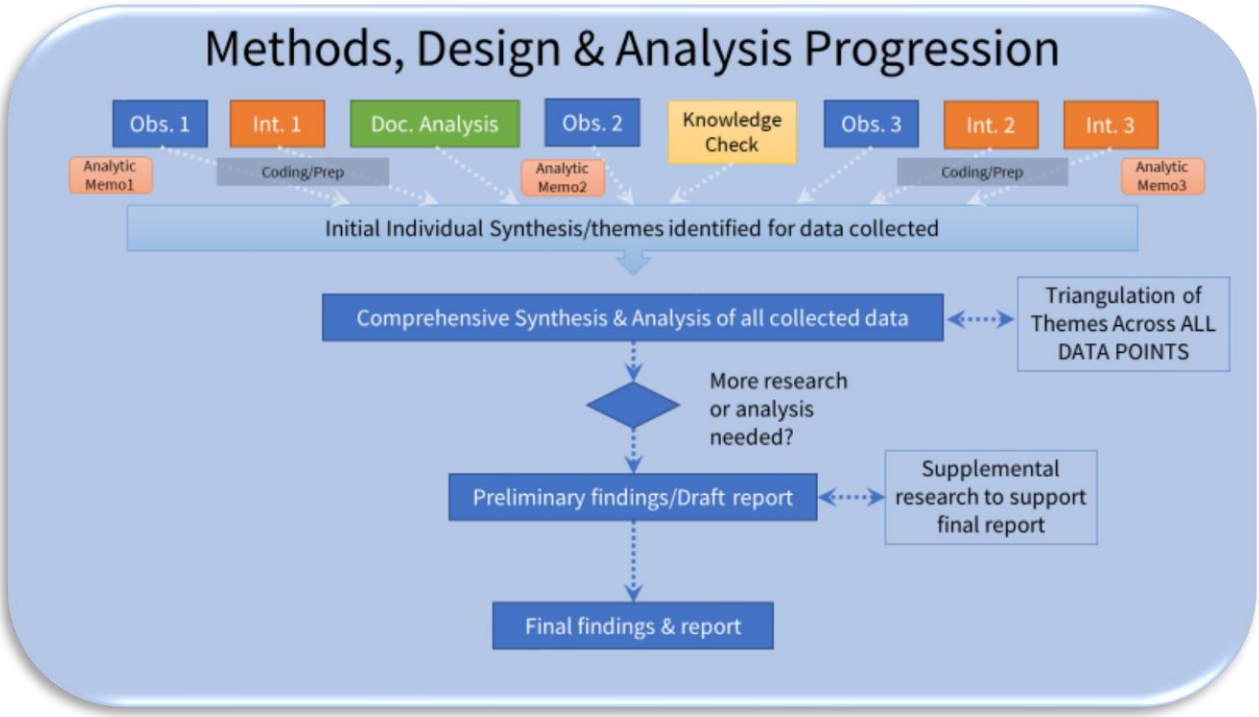
to determine whether the pilot impacted the students. These interviews also gave the authors a chance to better engage with the SEEDS staff and further develop those relationships, which emphasized the social justice aspect of this study. The Interview Protocols for Questions #2 and #3 can be found in Appendices C and D, respectively. Please note, Research Question #1 was not directly addressed in the interview protocols as it was expected that the data for this research question would come more from the observations; however, some data from the interviews did in fact provide information about the first question (discussed further in *Findings).*

The final data tool was document analysis. The authors analyzed the public facing documents used by SEEDS to determine the mission and vision and analyzed the formal documents used by both our organization and the pilot curriculum. Specifically, the authors reviewed the SEEDS website, SEEDS' logic model, SEEDS' budget, SEEDS most recent annual report (2018-2019), and the FarmBeats Curriculum. Although the explanation of analysis is below, the authors reviewed the above documents to determine the audience, the value, and the goal or mission. Once we reviewed the documents and recorded our own observations, we went back and analyzed them to determine if they provided data that related to any of our findings.

When we initially designed this study, we planned to also collect knowledge check data from the program as well as to interview the Farm Manager. Both elements were ultimately abandoned because there was missing data and the manager was no longer part of the organization. However, we were able to garner much information from our own observations of the students across the pilot and used that data to help develop our findings. Still, we believe the data we were able to collect was sufficient in providing enough material to truly understand the organization and its needs and allowed us to answer our study questions.

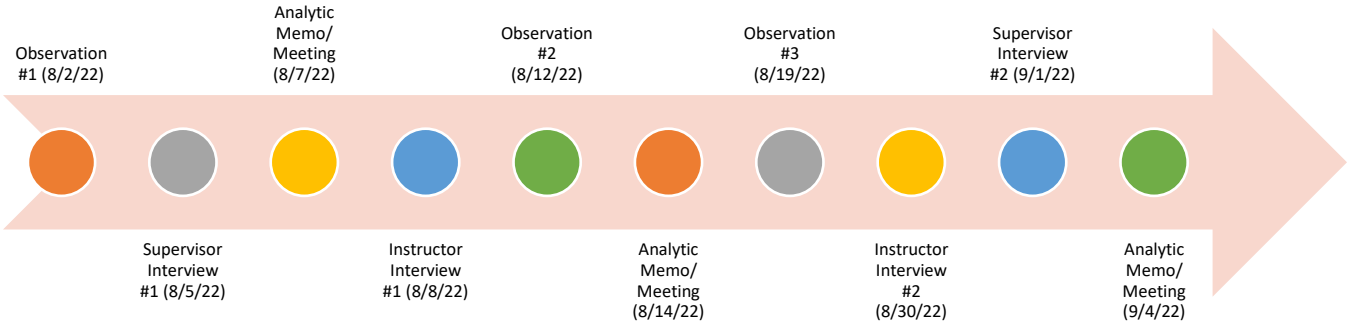
To provide a greater understanding of the methods used, please see the progression of methods, design, and analysis for data collection in Figure 7 below.

Figure 7: *Methods, Design, & Analysis Progression*



As indicated in Figure 7, the data collection was a very linear progress with observations at the beginning, middle, and end and interviews at the beginning of the pilot and at the end. After each observation, the team either completed a written analytic memo about the experience or discussed our initial analysis and thoughts in a team meeting. These memos and conversations were invaluable when it came time to analyze the data. Document analysis was conducted towards the end of the project but was also initially reviewed at the beginning of designing the project. The exact timeline of data collection is below:

Figure 8: *Data Collection Timeline*



Data Analysis

As evident in Figure 7, analysis was built into our overall study design and occurred throughout the project. After collecting each element of data, the study authors met as a team to discuss our preliminary thoughts about the data collected. We also used this time to revisit our process and determine if we needed more data based on what we were seeing.

Ultimately, the team determined that we needed a formal analysis process to develop consensus around our findings. We adapted a data analysis protocol modeled by Nancy Love, author of "Using Data/Getting Results,"(Love et al., 2002). The team then adopted additional questions adapted from the "Guide for Standard Bearer Schools: Focusing on Causes to Improve Student Achievement" (CTAC, 2014). That data analysis protocol is described below and can be found in Appendix E.

This data analysis contains 11 separate elements of data. They include observation notes (3), four interviews (7), and the document analysis (5 documents). Each study author used this protocol to analyze our own observation data and then review the interview transcripts and notes. First, each study author individually

analyzed their own data collected. Next, team members focused on the theoretical and conceptual frameworks to interpret the data to identify key thematic connections to existing literature or to identify areas that required supplemental literature review. Finally, we took a systematic approach comparing the study-team's data interpretations to identify potential recommendations and findings all study team members agreed upon.

The initial findings were guided by our coding analysis and themes. We allowed the codes to develop organically from reading the literature and developing a shared understanding of what we were looking for- elements related to STEM identity, STEM student engagement, and opportunities to learn.

For our own work, the themes, definitions, and coding mechanism are identified below:

Table 2: *Themes in Coding*

Theme	**Defined**	**Coding Mechanism**	**Related Literature**
Relatable	Applying to the students' lives	Highlighted Yellow	Shah et al., 2017
STEM Identity	An individual's label of a STEM persona	Highlighted Green	Dou & Cian, 2022
STEM Acumen	One's ability and knowledge in and of STEM	Highlighted Blue	Shah, et, al., 2017; Dou & Cian, 2022
Curriculum	The formal documents guiding the implementation of the pilot and/or the DIG program	Highlighted Purple	Martin and Fisher-Ari, 2022
Community	The area that SEEDS serves (Durham, NC)	Highlighted Orange	Scribner, 1986; Saxe, 1988; and Lave & Wenger, 1991

After identifying themes and triangulating the data, we were ready to determine what the data was telling us and identify findings and recommendations.

Findings

This section of the report provides a clear set of findings that answer the research questions and are a product of the analysis process. It is followed by the final section which articulates recommendations that are tied explicitly to the findings and grounded in relevant scholarship and practice.

Overall, we have five major findings which answered our three study questions. The findings, discussed in more detail below, are as follows:

1. SEEDS' organizational STEM identity is underdeveloped which limits the organization's ability to meet the STEM needs in the community. (Community)
2. Negative self-reported Instructor and Supervisor STEM identity may inadvertently reinforce misplaced stereotypes, and perpetuate low expectations for youth participants (STEM Identity)
3. With reduced STEM acumen in the instructor, we saw a decrease in the depth of instruction for the students. (STEM Acumen)
4. Delivery was impacted when non-STEM instructors lacked STEM knowledge. While the curriculum was designed for non-stem instructors, delivery was impacted by the instructor's lack of context knowledge to make connections. (Curriculum)
5. STEM identity of students showed positive change both as self-reported and observed in post-pilot data collection (Relatable)

Detailed Findings

Finding #1: SEEDS' organizational STEM identity is underdeveloped, which limits the organization's ability to meet the STEM needs in the community. (Addresses RQ#1)

SEEDS' documentation clearly states that SEEDS seeks to "develop the capacity of young people to respect life, the earth, and each other through growing, cooking, and sharing food" (See *Document Analysis*, Appendix F). The mission does not include anything about STEM or improving students' futures. However, in conversations with SEEDS constituents, they all mentioned the need to move to a more academic model and align the work of SEEDS with STEM engagement (Supervisor, personal communication, June 10, 2022). This goal has not been incorporated into the organization and (as is made clear in Finding #2) the organization leadership may have a bit of an anti-STEM persona.

Yet, as noted in the finding, SEEDS organizational STEM identity is very much underdeveloped in that not only is it not an official part of their mission, but it is not directly aligned with any current programming (See *Budget* in Appendix G). With no clear curriculum or plans in place of any of their current programing (Supervisor, personal communication, August 2022), SEEDS does not have the ability to infuse STEM into the current curriculum but could and should consider STEM as an instrumental element to plans to move forward. Still, this lack of planning, regardless of the lack of STEM, is a challenge for the organization because there is no consistency with which to build an organizational STEM identity. One interesting data point was when the instructor noted that he had "been able to implement curriculum and a lot of those things according to the mission statement that SEEDS already have (sic) and then established subsets of mission statements for each individual program that also aligns back to it and yet still has integrity and autonomy for its own program in itself as well" (Instructor, personal communication, August 8, 2022). He noted that he had developed these mission statements, but they were never produced or shared in any capacity. It appears the knowledge of a need for clear mission statements and curriculum plans was known, but not executed.

The lack of STEM identity was also clear with the organizational leaders. In fact, during the supervisor's first interview, when asked whether she had reviewed the curriculum, the supervisor stated: "Yeah, I looked at it a little bit. …I have a bachelor's in fine arts, and I picked art on purpose because I really hate writing or reading a lot of stuff. …and so the second I see a ton of words. I'm like, I'm out. I was like, *Instructor*, you be in charge of this. Like you read this, you interpret it." (Instructor, personal communication, August 8, 2022). The clear indication was that she was not a STEM person and as the leader of this organization, had already made clear to her staff that this was not "her" work. By delegating the work in that way and with that explanation, her personal STEM persona became the organization's STEM persona. This is also evidence of Finding #2, discussed further below.

Furthermore, the staff often described themselves as "volunteering" or donating their time to SEEDS, rather than as a place of employment. For example, the supervisor who was the acting director of SEEDS and a member of the Board noted that she works for STEM in a "weird capacity" with volunteer hours numbering 5 to 20 hours and discussed her need to volunteer time when staff walked out in October of 2021 (Supervisor, personal communication, August 5, 2022). This notion of service, that even when being paid, individuals were giving of their time and perhaps working for less than they felt it was worth, tended to undermine the mission of the organization.

The importance of developing a strong STEM identity is supported by the literature (Dou & Cian, 2022; Shat, et., al., 2017; Wang, 2013). Without a strong STEM identity, students are less likely to engage in STEM in the future, potentially disadvantaging themselves at an early age (Dou & Cian, 2022; Wang, 2013). Based on this literature then, this finding is unsurprising given the cultural background of the individuals who work at SEEDS. Still, as the research notes, this may lead to more problems for the community SEEDS is trying to help. Still, it makes sense from an organizational leadership perspective that clearly aligned missions and visions lead to sustainable and actionable goals (Weintraub et al., 2021). This will be explored further in Recommendations #1 and #2.

Finding #2: Negative self-reported Instructor and Supervisor STEM identity may inadvertently reinforce misplaced stereotypes and perpetuate low expectations for youth participants. (Addresses RQ #1)

As noted in Finding #1, both the supervisor, who is the acting leader of the organization, and the instructor, who implemented the pilot program, described themselves as being "not STEM people". It is important to note that both the supervisor (female) and the instructor (male) are African American and are role models, based on their positions, to the students within the SEEDS programs. The instructor told the study team "So I never had an interest in STEM. It was kinda sorta district mandated because of the content that I do teach…" (Instructor, personal communication, August 8, 2022). During one of the workshops, the instructor did not understand some of the technical terms and even said, "soil moisture, sensors detected changes in 'that word' then use electricity's ability to jump through material." He then stated, "there's a lot of big words huh?" and one participant responded, "uh huh". The facilitator then uttered "they need to simplify this, but that's ok because we're going to keep going like we know what we're talking about!" (Instructor, personal communication, August 2, 2022). Later, during observation number two, the facilitator stated while reading, regarding the material "too long, that doesn't make sense, that doesn't make sense!" His inability to articulate some of the material perhaps led to the students' reticence to fully engage as many were doing other things like painting or looking at their phones (Instructor, personal communication, August 12, 2022). The instructor's message to the students was that he is not a STEM person, did not understand the materials, and that it was ok to just skip over things.

In Finding #1, we also noted the supervisor's anti-STEM identity and her clear statements of not being a STEM person. She stated in her own terms, as quoted above, that she was not a STEM person (Supervisor, personal communication, August 5, 2022). Again, it is relevant that both the supervisor and the instructor are African American because the students in the program were predominantly African American and likely see the SEEDS leadership as role models. The supervisor and instructor's lack of STEM identity and confidence may have

unintentionally reinforced the students' preconceived notions about minoritized individuals in STEM. As discussed in the research synthesis, the literature supports that there is a perpetuated myth around Black people being unable to be successful in STEM fields (Fry et al., 2021; McGee et al., 2021). As this myth continues, and students are perhaps only exposed to minoritized individuals with negative STEM personas, they are likely to continue to believe the myth rather than verify the fallacy.

Furthermore, the negative personal STEM identities of the leadership may have impacted their own views of the students. For example, when asked before the pilot, how many of the students may have some STEM identity, the instructor responded, "I don't think any of them really" (Instructor, personal communication, August 5, 2022). When asked the same question, the supervisor stated "I'd say 10% maybe know about STEM. I don't know if any of them actually are, would say they have a STEM identity, they don't go to schools that are STEM heavy… So I'd say maybe like 10% have some stem identity or feel like they could be comfortable with STEM, but like 90% maybe could take it or leave it or not like negative way, but more like a neutral" (Supervisor, personal communication, August 5, 2022). Yet, when we asked about the students' future interests, both the instructor and supervisor told us at least one student wanted to be an engineer (Supervisor, personal communication, August 5, 2022; Instructor, personal communication, August 30, 2022). The instructor mentioned trying to make connections for the students to how his desired career is related to STEM, but neither the instructor or supervisor really seemed to think that engineering is STEM or that this student could succeed and did not define him as having a STEM identity.

When asked more specifically "How many of the interns do you feel would be a good scientist, engineer, mathematician, or technology expert one day? (Why do you feel that way? What are some indicators you have seen?)" the supervisor stated "I can't think of any; At Duke, it's like majority Indian, some white people, maybe 1 Black person, but these kids don't have anybody in their family or like, in college, its a stretch, Sounds like the moon, right?; They're all super smart, but they have a confidence issue; A few of them in my mind that were definitely like, I don't know what I wanna do, but it's you know, I don't think I'm that smart, so…its kind of sad. I

could see them like potentially doing your career (to author who is a STEM expert), but I don't know how to get them there; Like, I'm not the right person to figure it out; They definitely don't have, like, I get the sense from some of them that their parents don't have time to, like, go over some of this stuff, and there might be like one counselor for their whole class or their whole school; And if you write a sad enough letter, that's how you get college paid for" (Supervisor, personal communication, August 5, 2022). This response really emphasized the supervisor's, who again was the acting director for the organization, belief that she was not the appropriate leader and did not know how to guide these students into their future, regardless of whether it involved STEM.

Perhaps even more disheartening, when the instructor was asked the same question, he stated "I don't think that is anywhere in their focus because that hasn't been presented as such" (Instructor, personal communication, August 30, 2022). The instructor shared this information while admitting that the organization is not currently presenting STEM as an option for these students. Furthermore, the low expectations for the students, the insecurity of the leadership, and the lack of leadership in SEEDS are all evident in this data. Whether the reason they have low expectations for their students is because of their own lack of STEM identities may be beyond the purview of this study, but it was clear the leadership felt negatively about their own aptitude in STEM and their students' futures in STEM.

The literature describes a pervasive myth that Black people are not associated with or do not belong in STEM fields (Fry et al., 2021; McGee et al., 2021). The perpetuation of this false narrative continues to disadvantage minoritized children and must be addressed. It is imperative that the leadership see their own positions as intricate to the organization and see the organization as one designed to propel minoritized students into STEM fields. This will be addressed more clearly in the recommendations section in Recommendations #1 and #2.

Finding #3: With reduced STEM acumen in the instructor, we saw a decrease in the depth of instruction for the students. (Addresses RQ #2)

The FarmBeats content includes a detailed 20-day timeline, hardware build instructions, student activity guides, sample questions & answers, agriculture and technology teacher notes, and PowerPoint presentations (Microsoft, 2022). The lesson guides provide step by step scripts for the instructor which is designed to allow anyone to teach these lessons. This appeared to initially be a distinct advantage the Microsoft program as we knew there was not an instructor at SEEDS that is an expert in STEM. However, it was clear in our observations and interviews that the level of instruction was not as deep as it could have been because the instructor did not understand the content.

In addition to the examples that have already been shared, study authors noted in another example in Observation #1 that when the instructor was teaching the students about the importance of artificial intelligence and how it can be used as a social justice tool to fight things like world hunger and climate change. The script noted that there is currently more salt in the ocean than ever before (connecting climate change and the water cycle). One student stated she did not understand how the salt in the ocean got into the soil and the instructor did not answer her question and kept moving on with the lesson (Instructor, personal communication, August 2, 2022). This was a missed opportunity to connect the learning with the water cycle, but it seemed the instructor did not understand the connection himself. He acknowledged this in our second interview when we asked whether he thought the pilot would make a difference for the students. He responded, “I think it will make a difference. It would have made a huge difference if I actually have a background” (Instructor, personal communication, August 30, 2022).

Another example occurred in the second observation. The instructor’s lack of familiarity of some terms was clear and resulted in missed opportunities to connect or promote STEM content learning. For example, when discussing digital technology and binary format – the instructor glossed over many terms without any real

connection to the meaning (Instructor, personal communication, August 12, 2022). These continued missed opportunities stacked up to missed opportunities to learn and although we did see an increase in STEM identity, we hypothesize that had these connections been made, the growth in identity would have likely been deeper. This is a topic for future research.

Finally, there was evidence that the missed opportunities did impact the students' learning. Specifically, participants demonstrated a lack of recall or understanding of topics covered in earlier lessons. The instructor's quiz recap (observed during Observation #3) identified student challenges in recalling the "big ideas" that would have been covered for close to 20 lessons at this point if the instructor and participants were engaging in a consistent review of the learning goals and a review of content covered (Instructor, personal communication, August 19, 2022). We were only present for three of the 20 lessons, but the final observation was also the final lesson and we expected to see a clear knowledge base from the students. Unfortunately, while we saw increased engagement and students seemed more comfortable with STEM, they did not necessarily gain the content knowledge we would have expected. We are unable to confirm this with the knowledge checks that were conducted at the end of the pilot, but we believe those results would have solidified this finding.

This finding is consistent with the literature on the Out of School Time STEM Program Dimensions of Success and STEM identity development (Shah et al., 2017 and Wang, 2013). One of the most important factors in the success of Out of School Time STEM programs is the instructor's ability to relate the content to the students (Wang, 2013). This finding would lead us to expect that students are unlikely to learn as much as they could under the current circumstances. This literature was instrumental in guiding our understanding of the data to identify this weakness in the STEM acumen of the instructor. Still, the instructor consistently missed opportunities to build STEM knowledge and that impacted the depth of the students' learnings. This data and finding are reflected in Recommendations #3 and #4 detailed further below.

Finding #4: The curriculum failed to meet expectations by not providing relatable material and support for Instructors which impacted delivery when non-STEM instructors lacked STEM knowledge (as related to Finding #3). While the curriculum was designed for non-stem instructors, delivery was impacted by the curriculum's lack of support in making connections. (Addresses RQ #2)

While this sounds similar to Finding #3, that focuses on the STEM acumen of the instructor, whereas this finding is about the actual Microsoft Azure FarmBeats curriculum. As one of the study authors is a SEEDS' donor and Board member, he was privy to conversations among the SEEDS Board and staff about the future of the organization. When the Board discussed options, it was important to find a program that did not require content level expertise (Supervisor, personal communication, June 10, 2022). The FarmBeats curriculum was chosen, at least in part because of this feature. The program has a robust set of teacher resources and was designed to provide knowledge to the instructor so that they may share that knowledge with the students (See: Appendix H *Data Analysis - Teacher Resources)*. It states the desire to make students autonomous in their learning, which also indicates less of a need for a STEM expert to instruct (Microsoft, 2022). Specifically, the curriculum materials state that "the student kits are designed to empower your students with the skills they need to solve real-world problems while also introducing the basics of AI, Machine Learning, and data literacy" (Microsoft, 2022). Yet, as we noted above, there was a real challenge in the depth of teaching and learning due to the instructor's inability to make content connections. The instructor was phenomenal at connecting the content to the students and making it relatable, as discussed in Finding #5, but could not connect the STEM content with prior science and STEM knowledge nor the STEM components of DIG gardening tasks.

We recognize that many nonprofit organizations, like SEEDS, may not be able to hire a STEM expert to implement instruction, but still desire to enhance their offerings with connections to STEM. This led us to look more deeply at the curriculum to determine how it could be made more teacher friendly. We also asked the instructor in our interviews about his thoughts on how to make the curriculum more accessible to the instructor.

Finally, as one member of the study team is a trained and certified educator, with a Masters in Instructional System Designs (Curriculum), we looked at the curriculum with a lens towards curriculum improvement.

When we asked the instructor what he thought the curriculum should include he stated “Aha moments for readers of that age so that I wouldn't have to try to find it myself, or at least something relatable to where it's not like a tedious task for them. But it's actually something that will be intriguing where they want to ask their own questions as of what's up? More, what else can we do type thing instead of me having to prompt it?” (Instructor, personal communication, August 30, 2022). This quote indicates the instructor’s frustration with the curriculum. He did not think the curriculum, as written, related to the students prior knowledge and he struggled to make those connections himself.

Although he did not differentiate between content knowledge and student relatability, the instructor’s comments indicate he did want to make deeper connections. He further stated “I don't think it [the curriculum] failed to meet my expectations. The curriculum for me was just like I said, trying to figure out how to convey it to these set of teenagers, because you know, regardless of their age, their experience in the world matters, and that dictates a lot. So, trying to figure out how to convey it to the audience I was supposed to convey it to was the only thing for me. But I wouldn't say that it did not meet my expectations. I enjoy STEM. I've worked with them before, so I was waiting to see what I got out of it…” (Instructor, personal communication, August 30, 2022). He recognized the reciprocity in teaching, while passively demonstrating his own frustration that the curriculum did not provide the necessary support to make connections with students.

The supervisor had stated she did not read the curriculum (as quoted above), but also when asked in her interview whether there were any challenges with the FarmBeats curriculum stated that “having to condense the curriculum was a challenge" and that "SEEDs had issues and needed more time to implement" (Supervisor, personal communication, September 1, 2022). This is an interesting comment as we had been discussing this project with SEEDS for many months before the commencement of the pilot and at least two authors

volunteered regularly during the four months prior to the pilot. Furthermore, the curriculum was shortened due to the request of the organization, but it is possible that a full 6-week implementation may have reduced some of these concerns. As aforementioned, the educator member of our study team adapted the curriculum with physical dates and explanations to allow the lessons to be doubled (two 45-minute lessons a day) and reduced to a three-week timeline, remaining faithful to the time needed to complete all 20 lessons. That lesson plan timeline can be found in Appendix A.

Still, both the supervisor and the instructor recognized the value and potential the FarmBeats program has for SEEDS. In fact, when asked what she liked about the FarmBeats program, the supervisor stated, “Looking at how tech and gardening can be STEM and teaching students more about what else is STEM… I consider the potential it has for SEEDS" (Supervisor, personal communication, September 1, 2022). The instructor was more specific and noted "It was enjoyable and great…lots of information and reflection… there is no spoon feeding, it is about critical thinking" (Instructor, personal communication, August 30, 2022).

This finding is consistent with the literature on the value of high-quality curricular resources being available in community-led programs leading to richer outcomes for participants (Martin & Fisher-Ari, 2022; CAISE, 2002). As the program did see some increase in student interest, it is fair to connect that to the curriculum itself, designed by Microsoft, and complimented by the instructor. The literature and our data for this finding are related to Recommendations #3 and #4, detailed further below.

Finding #5: STEM identity of students showed positive change both as self-reported and observed in post-pilot data collection. (Addresses RQ #3)

The final finding is directly related to the students’ STEM identity, the subject of the third study question. We wanted to know if programs like FarmBeats would increase student STEM identity, which the

literature tells us, also increase students' likelihood for success in STEM fields (Dou & Cian, 2022; Wang, 2018). The data from both observations and interviews indicate that the pilot did increase the students' interest in STEM, improving their STEM identity. When asked directly if students showed growth, the instructor noted that at least three quarters of the students did show growth (Instructor, personal communication, August 30, 2022). The supervisor reported she felt students had a "small to medium" STEM identity after the pilot (Supervisor, personal communication, September 1, 2022) whereas before the pilot she noted only one student potentially had any STEM identity (Supervisor, personal communication, August 5, 2022). As further discussed in limitations, this finding is based on the instructor and supervisor's impressions which we acknoledge are biased. This is not objective data, but as we were not able to interact directly with students to measure their interests more formally, this data is still relevant to the study at hand.

We wanted to understand why the program appeared to increase the students' STEM identity and interest. We learned through the literature that persistence in STEM, coupled with early STEM interventions reinforced positive student STEM identities (Dou & Cian, 2022) and that a positive STEM identity is a predictor of pursuing a STEM major (Wang, 2013) and ultimately a STEM career (Dou, et al., 2019). We knew it was important then for the students to persist and to remain engaged. We used our observations of the pilot using the Dimensions of Success framework to help us identify the individual dimensions of learning. When we dug deeper into the data, it became clear that what made this pilot successful in engaging the students in STEM to improve their STEM identities, was the instructor's ability to relate the material to the lives of the students.

There were multiple examples of the instructor's relationship with the students and his ability to connect the material to their lives. One example that stood out was when they were learning about how artificial intelligence can be used with facial recognition. At first the students did not necessarily see a connection and then the instructor asked them how they use facial recognition in their everyday lives. Pretty soon the students connected the lesson to their use of cell phones. It was clear throughout observation #2 the

instructor was making connections with everyday items like Google, Netflix, Smartphone, etc. (Instructor, personal communication, August 12, 2022). We noted that while the instructor struggled with connecting to scientific content, he was very good at explaining how every day we use STEM in our daily lives. In fact, when we asked the instructor about the curriculum, he specifically stated that making the curriculum relatable is what "makes the big difference" (Instructor, personal communication, August 30, 2022).

The second important element of this finding will lend itself to Recommendation #3, that SEEDS adopt the FarmBeats curriculum as a permanent part of the DIG student summer curriculum. Part of the reason we wanted to evaluate the pilot was to determine if it was an appropriate vehicle for SEEDS to further its mission of infusing STEM into the organization. Although we believe the pilot could have been much more successful, we believe that the true value is in the growth seen in the students' engagement with STEM. Because the data indicated that students did increase interest, we believe that implemented with more fidelity and either an instructor with STEM acumen, or a more detailed curriculum guide, this program can propel SEEDS forward in connecting gardening to STEM.

Ultimately, the finding that the program increased student interest was consistent with research showing that community-led programs that connect STEM to underserved youth can positively impact the problem of inequitable representation because the minoritized students that participated in this program were positively impacted (Baran et al., 2019; Burg et al., 2016; Collins & Halverson, 2010; Steiner et al., 2019; Tan et al., 2018). Furthermore, our conceptual framework is built around foundational learning theory (Lave & Wenger, 1991) and opportunities to learn (Green & Gresalfi, 2008) which explain that communities of practice where participants are learning peripherally, with an ownership over their own learning, are more successful. The participatory nature of FarmBeats, coupled with the focus on students' autonomous learning, makes it a good match for SEEDS' goals which is discussed further below in Recommendation #5.

Limitations

Throughout this report we have tried to acknowledge the limitations in our study. As we noted in the research synthesis around equity and research in community, it was very important to us to humanize our research and provide findings and recommendations that were relevant to the organization. Another aspect of equitable research is to provide transparency in data collection methods and analyzation which includes understanding the limitations of our study. We believe there are at least four important limitations to this study.

The first limitation is the very small sample size as the DIG program only included six students. Three students showed up for the first observation. After we rewarded those three students with $25 Amazon gift cards, the other 3 DIG interns showed up. We provided incentives to participate in the final two observations as well, but students had to have been participating in the daily lessons to be able to understand and engage in the observed sessions. We recognize that a sample size of six is a very small sample and not enough to project beyond the actual participant group.

Furthermore, by incentivizing the students, we cannot claim their initial interest is STEM based. We had discussed this early in the design process and felt that it was a fair trade off to incentivize students. Our justification was based on the understanding that many organizations working with minoritized students may need to incentivize students to garner interest. Students are not interested in something they have not been previously exposed to and we know there is a lack of exposure to STEM in minoritized communities (Fry et al., 2021; Martin & Fisher-Ari, 2021; McGee et al. 2021; Watkins, 2018). Still, we believe there is value in their experience for the organization as it considers its future planning. It may also serve as a preliminary analysis into OST STEM Programs in minoritized communities that may interest other researchers to delve deeper. This provides validation for incentivizing students to participate in STEM, but potentially clouds if there was a natural interest among students or simply a response to incentives.

The second limitation was the timeline. To meet the requirements of this capstone project experience, data had to be collected over the summer. To meet the needs of SEEDS' summer programming, the timeline had to be shortened from the typical 6-week curriculum to a reduced 3-week curriculum. This may not have had any impact on the overall program, but as we have not observed the program implemented over 6 weeks, we want to be clear that we understand we altered the FarmBeats program which may have impacted overall delivery and results.

In our research synthesis on the literature in equity in research and community, we discussed the importance of designing our study with the Design Principles for Justice which are first and foremost receptive to the needs of the organization (Costanza-Chock, 2020). We accommodated SEEDS' needs by revising the curriculum timeline to be taught in a shorter window of time. However, we acknowledge that had they followed their own timeline, perhaps waiting to implement in the fall, they may have had more impressive gains in student STEM engagement and STEM identity. Yet, even with the timeline modified, the organization did complete the entire curriculum. This was made easier by the fact that there was not an official curriculum for it to replace. In fact, DIG interns worked in the gardens throughout the day until they participated in the FarmBeats lessons in the afternoon. There was no other structured time for the DIG interns that we observed in the programming.

The third limitsation is in the ability to extend this analysis beyond the pilot FarmBeats program as the community-led STEM engagement program. There are many other programs that could serve a similar purpose to the FarmBeats program - linking STEM and agriculture, designed for nonprofit organizations, and promising to increase student STEM identity. SEEDS specifically piloted the FarmBeats program, and it would be inappropriate to expand these findings to other programs, including other programming at SEEDS in particular. This project was therefore an assessment of FarmBeats as implemented by SEEDS in their DIG program and not an assessment of SEEDS in general.

The final limitation, alluded to above, is that all the data about the students learning, perceptions, and identity growth are based on the opinions of the supervisor and instructor. Admittedly, these sources are biased and not easily verifiable. However, we were also able to supplement their opinions with our own observations, allowing us confidence in the overall findings.

We note in our analysis of the interviews that the SEEDS' leadership team shared initial interest in a program that could be easily led by any staff and that included all the elements necessary for successful implementation (Supervisor, personal communication, June 10, 2022). In all fair disclosure, two of the study's authors were familiar with Microsoft's Azure FarmBeats curriculum as they are employees of Microsoft. Neither works directly with this curriculum or the program management of the FarmBeats for Students Program. However, as employees of Microsoft, it was a natural fit for them to support a Microsoft program.

Still, the FarmBeats program contained all the dimensions of success identified by the DoS framework (Shah, et., al., 2017). Furthermore, the structure of FarmBeats lessons is consistent with best practices and should be consistent with other successful programs. Therefore, this analysis may help other researchers compare other community-led programs to this pilot or to further develop current community led programs by including more elements of relatability to the students as determined in Finding #5.

Recommendations

Although the limitations remind us that the value of our findings may be narrow and specifically related to our organization, the purpose of this quality improvement project was to specifically help improve SEEDS. Therefore, we have recommendations to improve STEM engagement in out of school time STEM programs for SEEDS, that may also be relevant for other similarly situated organizations. We developed six recommendations,

two for each initial study question and directly linked to the five findings across the study. The recommendations, shared in more detail below, are as follows:

1. SEEDs should design a cultural audit and a collaborative review of the cultural audit survey with the organization and the community constituents.
2. SEEDS should apply open data access and transparency to any research project with SEEDS to engage the community served.
3. SEEDs should adopt the FarmBeats for Students curriculum in their DIG program to increase positive student STEM identity
4. STEM programs should be taught by those with STEM backgrounds when student STEM backgrounds are weak.
5. SEEDS should partner with the local school system to align STEM activities with grade level skills
6. SEEDS should provide more exposure to minorities in STEM

Recommendation #1: SEEDs should design a cultural audit and a collaborative review of the cultural audit survey with the organization and the community constituents.

The first recommendation is directly related to SEEDS' desire to serve the community and their recognition that greater connection to STEM is imperative to their community members. Currently SEEDS' staff are guessing at what the community needs. For example, when the supervisor was asked in the second interview what she felt the community needed she stated "That's a tricky question because…not for their taxes to go triple. I mean, there's so many answers to that gentrification kind of doesn't help, but it's also making the neighborhoods a little safer. I would say access to healthier food. You know, the area we're in is a food desert. There's not really any supermarkets nearby" (Supervisor, personal communication, September 1, 2022). The instructor replied similarly with "It needs a lot… Someone to reach them where they are instead of trying to get

them to a location. I think that's the first thing meeting them where they are and then progressing on is what is needed more, more so than anything." (Instructor, personal communication, August 30, 2022). Both quotes indicate that SEEDS does not have a good system for understanding their community's culture or community's needs.

This lack of understanding of the community led us to dig deeper into the literature to determine how community-led programs can more successfully learn their communities. Developing a cultural audit of the community which would include questions about the demography, the practices, holidays, celebrations, and community perceived needs, is aligned with Costanza-Chock's (2020) *Design Justice Principle* #2 "to center the voices of those directly impacted" (p. 6). Understanding the audit would require SEEDS to partner with members of the community, other business leaders, school staff, religious community leaders, and neighborhood families to make sense of this data. Together, this audit can inform the program plans of SEEDS, aligning the organization's needs with the community's needs. Ultimately, such an audit would elevate the voices of the community members in the work being conducted to empower and support them (Costanza-Chock, 2020). The Center for Disease Control (CDC) created an example of such a community needs analysis which can be used as an place to start this work (CDC, 2013). This example was provided to the organization as part of this recommendation.

Recommendation #2: Apply open data access and transparency to any research project with SEEDS to engage the community served.

As a nonprofit organization with a defined interest in improving the STEM access of minoritized students in their community, the organization needs to be willing to partner with experts in STEM and in nonprofit community-led programming (Barnett & Camfield, 2016). In alignment with the Recommendation #1, SEEDS

must share their data and provide opportunities for both community members and interested educators to ensure the community's needs are being met. Innovation is built on understanding the context of the community and the work which requires co-owned studies between researchers and constituents. Every research project pertaining to SEEDS must include members of the community in its design, implementation, analysis, and agreement with the factual data-supported findings to align to proven practices in supporting social justice (Costanza-Chock, 2020).

The disconnect between the organization's STEM identity and the community's needs was clear when we asked the supervisor and the instructor how they believed SEEDS makes a difference to the community. The supervisor stated "I would hope that we help provide the healthy vegetables and fruits that they can't otherwise buy in a supermarket. And you know the whole child aspect of giving their kids somewhere to go after school that's not far away, that they don't have the bus to. And although a lot of ours don't live in the neighborhood, but just having somewhere that they can go to stay out of trouble and make some money and think that's something we provide" (Supervisor, personal communication, September 1, 2022). She is clearly focused on the perfunctory community needs of childcare and the direct production of fruits and vegetables. Yet, the only fruits and vegetables that are shared with the community are those in the "you-pick sections" which are two very small areas which are a miniscule contribution to the overall potential of food growing in the SEEDS outside fields. Her vision does not expand to the future of the students and the leverage SEEDS must use to improve those futures. However, by sharing the projects the students are working on (blueberry fields, different kinds of squash and berry planting, flower planting, etc.) the community could become more involved in not only the projects, but also the proceeds, the fruits and vegetables that are being grown. Furthermore, allow the community open access to the fields (during appropriate hours) and opening up the center as a community space as part of their current work, would go far in involving the community in the SEEDs mission.

Similarly, when we asked the instructor the same question, he responded “This makes a difference in the community because it literally gives back. This isn't taking anything from the community, so the people that we are reaching out to and the families that we impact don't feel like they must give something to get something. All they must do is be in need and SEEDS fulfills that need (Instructor, personal communication, August 30, 2022). Although his answer appears to be more holistic, he does not identify how SEEDS gives back to the community and after the admission from the supervisor that not all the students are from the community, we were concerned about who is included in designing the programs and their evaluations. Again, involving the community in future projects and programming, would include allowing them the information and data to influence the programming in a way that better relates and serves the community.

In our research synthesis, we acknowledged the importance of the “right for inclusion”, developed by Barnett and Camfield (2016), which demands that constituents have a voice in research project evaluation structures and processes (p. 6). In other words, community members need to be included in designing the research, not just participating in the questioning. Again, the *right for inclusion* is a key concern when program participants are students and the study design and processes are all being determined by adults. Students must be involved, to the extent possible, and community leaders and members should always be included.

However, the efforts must go beyond just including the community in the design process and must actively work to engage the community. It is not enough to passively ask for volunteers. SEEDS staff must be intentional in going out into the community and soliciting their opinions and ideas. Opening their data and being transparent in their work will go a long way to sharing SEEDS’ work and coupled with the community cultural audit, will really signal to the community that SEEDS is a community organization designed to support the Durham community it resides in. The current capacity of the community to support the organization is not clear but would be identified in the community audit.

Together, Recommendations #1 and #2 are related to Findings #1 and #2. As we noted in Finding #1, the SEEDS organizational STEM identity is underdeveloped, and Finding #2, that the instructor's and Supervisor's STEM personas emphasized myths around minoritized individuals in STEM. The recommendations to better understand the community through the audit and providing open data and transparency are designed to build better relationships with the community. It is through this community relationship building that SEEDS can leverage the success realized in the pilot.

Recommendation #3: SEEDs should adopt the FarmBeats curriculum in their DIG program to increase student STEM identity.

The third recommendation, alluded to in the explanation for Finding #5, is that we strongly recommend that SEEDS adopt the FarmBeats for Students curriculum, or something similar, as a permanent part of the DIG program. The program was chosen to pilot because it matched the characteristics SEEDS was looking for by providing a low-cost, highly interactive program, that relates to gardening and STEM. The project team donated 5 sensor kits to SEEDS for use during the pilot and that eliminates any real cost beyond staffing for an instructor, which could be accommodated with volunteer instructors. We suggest that if SEEDs do not choose the FarmBeats curriculum, that they find something similar.

The evidence that the students did in fact show increased interest in STEM after the pilot, was strong evidence of the greater potential of the curriculum. Although we acknowledge the limitation that we only looked at this one FarmBeats program, we also stand by our reasoning for choosing that specific program which included age-appropriate material for DIG students, easily accessible teacher resources and supports, and did not require experts for teaching the content. The observations and noted findings highlight the lack of

connection that is being made to current SEEDs programming and STEM. There is potential to leverage the FarmBeats curriculum to also make explicit STEM components already being executed by the DIG interns.

When we asked the supervisor and instructor how they thought that SEEDS could use the FarmBeats curriculum to attract more students into the DIG program their responses were clearly based on their own very different experiences with the curriculum. The supervisor recommended that we implement the program with middle school students. Specifically, she noted “Some of these high school students don't know what they're going to be when they grow up, but I feel like if we get them maybe at the middle school age, we could potentially influence them sooner and have them want to be more involved…middle schoolers are interested in coding and things like that, and then high school comes in they’re like I gotta get a job, I gotta graduate” (Supervisor, personal communication, September 1, 2022).

However, the supervisor admittedly did not read the curriculum and as a non-educator was not familiar with the level of knowledge and skill needed to participate in the FarmBeats activities. The content knowledge level is designed for high school age students who have some basic scientific knowledge around artificial intelligence, computer science, mathematics, and technology (Microsoft, 2022). She appeared to see value in using the program to attract students, but her lack of understanding of the program elements and content made her recommendation untenable. While her comments are in line with the literature that states that early intervention in STEM learning is imperative for improving outcomes in STEM for improving access and opportunities in STEM in minoritized communities (Beering et al., 2010;Baran et al., 2019; Estrada et al., 2018; Nava & Park, 2021; Sondergeld et al., 2016), it would seem more reasonable to consider adopting a program designed for younger students if the goal is to attract younger students into the SEEDS programs.

Conversely, when we asked the instructor the same question, he responded “Well first, I would say figure out a way to relate to them in a way that they will want to come without us having to just say, well, I need for you to do this because you need to do this. It has to be something that is going to draw them to it, not us

giving it to them and be like, hey, this is it now sit here and listen… Umm, I think once that happens, SEEDS can use that to expand their DIG program" (Instructor, personal communication, August 30, 2022). The instructor was clearly interested in attracting students to STEM due to the hands-on and exciting topics that students engage in. Instead, the DIG interns were told their participation was a part of their employment and as noted above, they were further incentivized with gift cards.

The instructor further alludes to the strength of a successful STEM program in advertising and recruiting when he notes that community partners will inquire "What's the STEM thing that we heard SEEDS is doing and that right there can be all that we need, that's the open door that we will need to you know unite (Instructor, personal communication, August 30, 2022). He acknowledges that success breeds more success but doesn't clarify that the success must come first. The community needs to know about the program, as described in Recommendations #1 and #2, to recognize its success. Full implementation with fidelity of the FarmBeats program would provide continuous data about the learnings of the DIG students and provide SEEDs an opportunity to connect STEM more explicitly to existing programming.

Recommendation #4: STEM programs should be taught by those with STEM backgrounds when student STEM backgrounds are weak.

The fourth recommendation is also related to Findings #3 and #4 which focus on the STEM acumen of the instructor and the support provided by the curriculum. Recommendation #4 is that STEM programs should be taught by those with STEM backgrounds when student STEM backgrounds are weak. This recommendation is consistent with the literature in that access and opportunity, specifically participation in STEM internships and programs for minoritized children, reinforce a students' STEM identity (Martin and Fisher-Ari, 2022; Dou and Cian, 2022, Wang, 2013; Dou, et.al., 2019). However, Just as Findings #3 and #4 are related to one another in

that if you have an instructor with a weak STEM acumen (Finding #3), you need a more thorough curriculum (Finding #4), so too are Recommendations #3 and #4. If the FarmBeats program is adopted and implemented with fidelity as suggested in Recommendation #3, then Recommendation #4, that STEM programs should be taught with someone with STEM expertise when students STEM backgrounds are weak, becomes less relevant.

However, as we acknowledged in our explanation of Findings #3 and #4, we believe that SEEDs, like other nonprofit organizations working to develop students' STEM identities, is unlikely to have the resources to hire a STEM expert to teach the FarmBeats program. Yet, when possible, we want to make clear that a STEM expert is more likely to ensure that the students can relate to STEM content and is especially important when the students have a weak STEM background. Students need to understand how STEM is already a part of their life and that they can be successful in STEM careers. Because poverty and minority status is associated with student success in STEM, we know that those in our target population are likely to have weak STEM backgrounds (Ferreira et al., 2015; Fry et al., 2021a; Watkins, 2018). Furthermore, when we asked the instructor and supervisor about the students' STEM knowledge, they both reported low to no STEM knowledge or interest in the DIG program before the pilot and increased interest and engagement after the pilot. The assessment of the students' STEM knowledge level then is based on the staff reports.

Finally, the need for either an expert instructor or a more detailed curriculum was also acknowledged by the instructor when he noted that students would have made deeper connections if he had a background in STEM (Instructor, personal communication, August 30, 2022). Throughout our formal interviews and informal conversations with the instructor, he was very confident in his ability to teach the content. However, in our observations and in our final interview it was clear that he was not always well prepared or comfortable with the content. His own acknowledgment of this came out in quotes such as the one above where he admits his own weakness in implementing the plans and the impact that had on student learning.

Recommendation #5: Partner with the local school system to align STEM activities with grade level skills

Recommendation #5 involves how SEEDS can continue to attract students into the DIG program in age-appropriate ways. Peripherally related to Finding #5, in that students were successful in the FarmBeats program, and implementation of the pilot did improve student STEM identities, we wanted to explore ways that SEEDS could build deeper connections with the students. Those connections involve partnering with organizations that support the places that students are found- namely the Durham public school system.

For a nonprofit organization looking to work with minoritized children and with a social justice-oriented mission, it is surprising that the organization has not previously partnered with the local school system. There is no connection, or knowledge, about what students are learning in their daily schooling and what they are learning at SEEDS. The instructor of the pilot was a public-school teacher, but a kindergarten teacher who had not taught high school and taught in a neighboring district (Greensboro County Public Schools).

It also became clear that there was a need for connecting with the local school system when the supervisor noted in her interview that “Some of the schools in Durham public schools, they're not really pushing STEM as much or they'll say they're doing it, but then they don't do it in a way that's interesting to the kids. So I'm hoping that they find this interesting and that they do want to” (Supervisor, personal communication, August 2, 2022). While she has a belief about the public school system, it was not clear that the belief came from knowledge on the students’ curriculum. A true partnership with the public school system, where SEEDS could share their goals and how they likely align to the K-12 curriculum, would benefit SEEDS, the school system and the students that are shared between the two. However, without knowledge of the curriculum in the school system, it was impossible for the instructor to make connections to the students’ general learning (i.e., the water cycle). Furthermore, the lack of knowledge around what students should know by grade level led to the supervisor recommending the material be implemented with middle school students who would not have had the appropriate background instruction.

This recommendation is also consistent with the literature in that the public school system is a missing constituent and partner in SEEDS' current dossier, as is evident in Table I: SEEDS constituents, which does not list the school system. Furthermore, effective research involves the community and community-led programs can influence and impact STEM engagement in minoritized communities. This was an important finding in the literature and informs this recommendation (Baran et al., 2019; Barnett & Camfield, 2016b; Burg et al., 2016; Collins & Halverson, 2010; Costanza-Chock, 2020; Steiner et al., 2019; Tan et al., 2018). By partnering with the local public school system, SEEDS may be able to build upon students' current foundations more effectively and engage more students by working with the school system to identify students who could benefit from SEEDS' programming. Although SEEDs current capacity may not allow a large influx of students, they can certainly handle more than they currently have enrolled with the current staff. Furthermore, their goal is to continue to expand, and this recommendation is in alignment with their goal, while acknowledging they will also have to grow capacity.

Recommendation #6: Provide more exposure to minorities in STEM

The final recommendation is that SEEDS intentionally expose DIG students to STEM professionals who are of minoritized races. This directly harkens back to one of the very first problems we discussed in this study- the lack of minoritized individuals in STEM (Fry et al., 2021; McGee et al., 2021; Watkins, 2018). The research is clear that minoritized individuals are underrepresented in STEM, but this recommendation provides guidance on what we can do about it.

Recommendation #6 specifically requires SEEDS to increase student exposure to minoritized individuals in STEM careers. It is hard for students to envision what they do not see and therefore it is imperative that they be engaged in learning that includes people of color. This should include field trips to agricultural programs at colleges and universities, visits to labs and other STEM arenas where students can learn about careers in STEM.

There are many successful minoritized STEM experts that could be invited to speak, or mentor, or contribute knowledge to the students in SEEDs.

The data supported this recommendation as evident when the supervisor noted that she "worked with the engineering department [at Duke University] a lot and a lot of the people are Indian. It's very interesting. It's like majority Indian, some White people, maybe 1 Black person. But these kids don't have anybody in their family or like, you know, college…" (Supervisor, personal communication, September 1, 2022). This made it clear that the supervisor herself had not been exposed to many successful STEM professionals of color and was transferring this belief to the DIG interns. By intentionally exposing students to successful STEM professionals of minoritized races, we can begin to change the narrative about who is successful in STEM careers. Such changes will bring further credibility to SEEDS' efforts to increase minoritized student access and opportunities in STEM fields.

Organizational Concerns and Responsible Parties

As we considered how feasible our recommendations are to the organization to ensure accurate implementation, we wanted to also identify any potential concerns around implementing the recommendations and be more prescriptive on where responsibility for the individual recommendations lay among the SEEDS staff. As each of the recommendations is designed to further SEEDS' overall goals, none require major organizational concerns as it is more about aligning the daily work and programming with the overarching goals of the organization.

The only concern we had around implementing our recommendations is that it does require SEEDS to rebrand itself as a STEM organization. Currently, neither their mission nor vision explicitly link their work to improving STEM access or opportunity in minoritized communities. SEEDS may want to consider a rebranding with a community celebration that highlights the STEM connections and offerings within its programs to further

illuminate this work. Still, it is not such a large endeavor as there is a natural marriage between agriculture becoming more industrialized and advancing STEM skills and strategies.

The responsibility of who should ensure that all programs are aligned with improving STEM access and opportunities falls directly to the Board of Directors. It is important to note that the instructor we worked with, who had been promoted to Executive Director, no longer works for the organization as of October 2022. The acting supervisor is now the chair of the Board of Directors and no longer acting as the supervisor for the program. Once again, SEEDS is impacted by high staff turnover and inconsistent leadership. The responsibility to infuse STEM into all aspects of SEEDS programming should fall to the Executive Director and the Farm Educator. However, since SEEDS is lacking consistency in staff, the ultimate responsibility lies with the Board in ensuring the recommendations are implemented and the mission of SEEDS is more directly STEM related.

In Closing

Although the study authors were pleased to see the increase in the students' STEM interests, it was disappointing from a social justice perspective to see the potential that went untapped because of the program implementation or the negative STEM organizational identity. Our study highlighted many of the negative stereotypes that created obstacles to success in STEM for each of the study authors. As social justice seekers, we were frustrated at the many missed opportunities to make connections to and with the students and the questions that went unanswered. Still, it was clear that the pilot was a success.

The hands-on nature of the activities coupled with the instructor's ability to really relate the material to the students' everyday lives appeared instrumental in improving students STEM identities. The instructor reported increased participation and engagement, but the study authors also observed increased engagement and understanding over the course of the pilot. Still, the findings noted the many missed opportunities and undiscovered connections that were due to the instructor's lack of content knowledge. However, by improving

their connections with the community; recognizing the strengths and weaknesses of the instructor, students, and curriculum; and expanding community partnerships to include the public school system and more minoritized individuals in STEM careers, SEEDS could further extend their outreach and more deeply meet their goals to improve STEM access and opportunity for the students SEEDS serves.

The study team believes the study findings and recommendations provide a strong path forward for the SEEDS Board of Directors to consider as they continue rebuilding the SEEDS programs. If SEEDS staff can focus the work on STEM access and engagement while developing stronger community partnerships and working with minoritized individuals in STEM fields, they will improve their current program immensely and provide more research-based programming to the advantage of the students and the community.

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Appendix A

Lesson Plan Timeline

FarmBeats 20 Lesson (Day) Curriculum

Lesson (Day)	In-Person	Virtual	Lesson (Day)	In-Person	Virtual
1		X	11		X
2	X		12		X
3	X		13		X
4	X(+overnight)		14	X	
5	X		15		X
6		X	16		X
7	X (+4 days)		17		X
8	X		18		X
9	X		19		X
10		X	20	X	

Schedule:

Monday August 1:	Lesson 1	
Tuesday August 2:	Lessons 2 & 3	Team present for observation/tech assistance/interview
Wednesday August 3:	Lesson 4	
Thursday August 4:	Lesson 5	
Friday, August 5:	Lessons 6 & 7	
Tuesday, August 9	Lessons 8 & 9	
Wednesday, August 10	Lesson 10	
Thursday, August 11	Lessons 11 &12	
Friday, August 12	Lessons 13 & 14	Team Present for Observations
Monday, August 15	Lessons 15 & 16	
Tuesday, August 16	Lessons 17 & 18	
Wednesday, August 17	Lessons 19 &20	Team Present for observation/interviews

Appendix B

Observation Protocol

Observation Protocol Directions to Observers:

Allow for 5-10 minutes of the lesson and STEM activity to pass before starting observation notes.

Begin with the page 2 "Domain & Dimensions of STEM Engagement Observation Notes", and after 10 minutes of observation, assign a rating from the Observation Rating from the rubric below of 1 (not evident/minimal) to 5 (highly evident and consistent) to each dimension and make notes to support the rating choice.

Evaluate each dimension of the domains listed. If you cannot precisely select a rating to reflect the level of evidence observed, then move down or up to the adjacent even number that more accurately reflects the item's presence within an observed activity.

Continue to make notes on Page 2 until the STEM activity is completed. Once completed, update the page 1 summary to offer a brief description of the activity and any key notes from observation.

Observation Rating Rubric*:

Level 1 Evidence absent	Level 2 Inconsistent evidence	Level 3 Reasonable evidence	Level 4 Compelling evidence
Minimal evidence that the youth are engaged in hands-on activities in which they can explore STEM content.	Weak evidence that the youth are engaged in hands-on activities in which they can explore STEM content.	Clear evidence that the youth are engaged in hands-on activities in which they can explore STEM content.	Consistent and meaningful evidence that the youth are engaged in hands-on activities in which they can explore STEM content.

Observer's Synthesis: Please provide a summary of the activity and note how the activity demonstrates core features of STEM engagement as observed:

Activity Summary:

Observer:_____

Date:_____

Domain & Dimensions of STEM Engagement Observation Notes*

Domain	Dimension	Observation	Level
Features of the learning environment	Organization		1/2/3/4/5
	Materials		1/2/3/4/5
	Space Utilization		1/2/3/4/5
Activity engagement	Participation		1/2/3/4/5
	Purposeful Activities		1/2/3/4/5
	Engagement with STEM		1/2/3/4/5
STEM knowledge and practices	STEM Content Learning		1/2/3/4/5
	Inquiry		1/2/3/4/5
	Reflection		1/2/3/4/5
Youth development in STEM	Relationships		1/2/3/4/5
	Relevance		1/2/3/4/5
	Youth Voice		1/2/3/4/5

Dimensions of Success Rubric for Observation Consideration*:

Dimension	Rubric Description
Features of the learning environment	
Organization	Focuses on the extent to which the facilitator delivers the observed activities in a way that reflects appropriate planning and preparation, through having the necessary materials readily available, being ready to accommodate to changing situations, and having smooth transitions to prevent time loss and chaos in the learning environment
Materials	Focuses on the extent to which the activities make use of materials that are appropriate for the youth in a program, aligned with intended STEM learning goals, and appealing to youth.
Space Utilization	Focuses on the extent to which the program space is utilized in a manner that is conducive to STEM learning in an OST environment.
Activity engagement	
Participation	Focuses on the extent to which the youth have equal access to the activities offered. Participation refers only to general participation (access to materials, prompting to participate and contribute, etc.) in the activities and does not consider the degree to which the youth are participating in STEM thinking/reasoning or inquiry practices.
Purposeful Activities	Focuses on the extent to which activities are structured so that youth clearly understand the goals of each activity, and the connections between them; it also examines the degree to which the facilitator uses his/her time productively to best support youth understanding of STEM learning goals.
Engagement with STEM	Focuses on the extent to which youth are engaging in hands-on activities that allow them to actively construct their understanding of STEM content. It also looks at whether or not the activities leave youth as passive recipients of knowledge from the facilitator or as active learners who interact directly with STEM content so they do the cognitive work and meaning-making themselves.
STEM knowledge and practices	
STEM Content Learning	Focuses on the extent to which youth are supported to build understanding of science, mathematics, technology, or engineering concepts through STEM activities. Observers must consider the accuracy of STEM content presented during activities, the connectedness of STEM content presented during activities, as well as evidence of youth uptake of accurate STEM content based on their questions, comments, and opportunities to demonstrate what they learned.
Inquiry	Focuses on the extent to which activities support the use of STEM practices. These STEM practices are usually used in the service of helping youth learn the science content more deeply. Stronger quality involves youth participating in STEM practices in authentic ways (versus superficially going through the motions of inquiry) to pursue scientific questions, address a design problem, collect data, solve an engineering task, etc.
Reflection	Focuses on the extent to which activities support explicit reflection on the STEM content in which the youth have been engaged. This dimension also refers to the degree to which the quality of youth reflections is superficial or meaningful and connection-building.
Youth development in STEM	
Relationships	Focuses on the extent to which the facilitator has positive relationships with the youth and other facilitators as well as the extent to which youth have positive relationships with each other.
Relevance	Focuses on the extent to which the facilitator makes connections between the STEM activity and the youth's lives and personal experiences, other subject areas, or a broader context.
Youth Voice	Focuses on the extent to which the STEM activities encourage youth to have a voice by taking on roles that allow for genuine personal responsibility and having their ideas, concerns, and opinions acknowledged and acted upon by others

*Based on the work of Ashima Mathur Shah, Caroline Wylie, Drew Gitomer, and Gil Noam. (Shah, A.M., Wylie, C., Gitomer, D., Noam, G. (2017). Improving STEM Program Quality in out-of-school Time: Tool Development and validation. The PEAR Institute-Partnerships in Education & Resilience. Harvard Medical School and McClean Hospital. Belmont, MA.

Appendix C

Interview Protocol 1

Interview Protocol – Project Impact Question Set #2

Interview Question 2: Will the availability of high-quality STEM curricular resources and technology support enable a community organization (SEEDS) to improve access and engagement with STEM topics for an underserved youth population?

Purpose Question 2: This question addresses the piloting of Microsoft's Azure Farm Beats program - all administration of program-impact and outcome survey data will be done by SEEDS staff. We will use this data, along with observations and staff interviews to respond to this project question.

Interviewer: _____ Interviewee: _____

Date: _____

Pre-interview overview:

The core focus of this study is STEM identity change with "Outside School Training" (OST) and "Informal STEM education" (ISE). STEM Identity is how one would think of themselves as a scientist, technology professional, engineer, or mathematician. People with a STEM identity gravitate towards those career paths.

Can STEM experiences within the SEEDS programming stimulate learning and lead to an increase in STEM identity?

PRE: We plan to ask you some questions about your background in STEM, your expectations about the STEM activities in the Farm Beats curriculum and activities, and your thoughts about how the student may participate in these activities.

POST: We plan to ask you some questions about how your thoughts on STEM may have changed, any thoughts about the Farm Beats curriculum and activities, now that you've completed them, and your observations of the students' participation.

Informed Consent:

Your participation is optional and the notes from the interview will be stored and coded for use without any personally identifiable information. That means your identity will remain anonymous as much as we can protect it. Your comments will not be shared with your name or any other identifiable information. You can stop this interview at any time.

We have now provided an overview of the purpose of the study and consent for recording and participation; do you have any questions before continuing?

General building of rapport:

We will start off with some questions to help us learn your background information and get to know you a little better. How long have you been working at SEEDS? How would you describe your work at SEEDS? What are some of the things that you like about working at SEEDS?

(*Ask some follow-up questions to clarify any answers shared. Make note of the instructors' answers and any details shared.)*

Pre-study questions:

Workshop Expectations

1. How would you describe the STEM instruction content with the Farm Beats curriculum and training content? (*Probe on depth/specificity i.e., Do they feel the content is helpful to prepare them to teach the STEM topics? Make note of the instructors' experience and any details shared.)*

2. At this point before you start, what are your expectations of the STEM workshop/activity? (*Probe on depth/specificity i.e., Have you taught something similar? If so, what were those outcomes? Make note of the instructors' experience and any details shared.)*

Self-Efficacy

3. Will you please describe your background in STEM – did you take relevant course work or have strong personal interests in studying Science, Technology, Engineering, and Math? *(Make note of the instructors' experience and any details shared.)*

4. How do you feel about teaching STEM to address topics related to SEEDs – like environmental problems, sustainability, plant health, etc.? (*Probe on depth/specificity i.e., Have you taught something similar? If so, what were those outcomes?)*

5. How confident are you in teaching principles that help students reason when finding the best solution for a problem? (*What are some of the indicators that students are finding the optimal solutions? Is there anything else you would look for? If so, what/why?*)

6. How confident are you in teaching all activities in this planned Farm Beats workshop/activity? (*Probe on depth i.e., Do you believe that you'll have to adjust your instruction? If so, why? If not, why?*)

STEM Identity

7. How would you describe the general level of familiarity with STEM topics that the DIG participants have?
8. What percentage of your interns may have a strong positive STEM identity or strong negative STEM identity?
   (Note - *Does the interviewee answer with an understanding of what is meant by STEM identity? If not, be sure to clarify STEM identity and note if they have shared any positive or negative STEM identity indicators in the participant group.*)

9. What percentage of the interns self-identify as potentially pursuing STEM topics in high school or beyond? *(Why do you feel that way? What are some indicators you have seen?*)

10. How many of the interns do you feel would be a good scientist, engineer, mathematician, or technology expert one day? *(Why do you feel that way? What are some indicators you have seen?*)

11. How would you describe the interns' understanding on whether studying STEM is beneficial for obtaining a STEM career in the future? *(Probe for specificity, is there any story or indicators you have seen that supports this perspective?*)

Post study questions:

STEM Interest/Identity

1. Did your outlook change regarding observed STEM identity for the participant interns? (i.e., *Did some interns show a greater than normal interest in the workshop? If so, why? Remind them of previous answer if necessary)*

2. How would you describe the general level of familiarity with STEM topics that the DIG participants have after completing the Farm Beats curriculum?

3. Based on the experience with the program, would you describe any interns that seemed to change their views on STEM or how they would define their STEM Identity? *(Note if they have shared any positive or negative STEM identity indicators in the participant group.*)

STEM Pilot Program Experience

4. What did you like about the Azure FarmBeats program?

5. Were there any challenges with the Azure FarmBeats program? (*If so, can you elaborate on the challenges, and why did you feel that way?*)

6. [SC] Are there things you wish this curriculum included? *(Probe for specificity – see if there are any examples or stories of improvement they would suggest.)*

7. [SC] How do you think students felt about the curriculum?

8. [SC] Tell me how STEM can make a difference in the world.

9. [SC] How did this curriculum meet your expectations? Fail to meet any expectations?

10. How can seeds use this program to attract more student interest in STEM (Probe for how it could be a regular part of SEEDS programming for DIG – or any other program like Summer Camp or After-school)?

Instructor STEM Self-Efficacy

11. Now that you've completed the workshop, would you change how you rated yourself in teaching STEM to address topics related to SEEDs – like environmental problems, sustainability, plant health, etc.? (*Probe on depth/specificity i.e., If not, why not? If so, why?)*

12. If you were asked to observe another teacher's Farm Beats workshop, what would you look for to decide whether the instruction is high quality? (i.e., *What are some of the things you would expect to find the instructor doing for the instruction to be of high quality? Can you describe what the discussion would sound like if the instruction were high quality?*)

13. Is there anything else you want to tell us about your experience with this program?

Appendix D

Interview Protocol 2

Interview Protocol - Project Impact Question #3

Interview Question 3: Will a DIG intern show deeper interest in STEM after the project? Are community STEM needs met by implementing a community-led program focused on improving access and engagement with STEM topics for the underserved youth population that SEEDS supports?

Purpose Question 3: This question is meant to explore the project impact on the social justice issues around minoritized communities central to the SEEDS mission and how STEM may impact the community. This will be done with post program activity interviews with SEEDS staff.

Interviewer: _____ Interviewee: _____

Date: _____

Pre-interview overview:
As we mentioned previously, the core focus of this study is STEM identity change with "Outside School Training" (OST) and "Informal STEM education" (ISE). Just as a reminder, STEM Identity is how one would think of themselves as a scientist, technology professional, engineer, or mathematician. People with a STEM identity gravitate towards those career paths. Ultimately, we are trying to determine if STEM experiences, within the SEEDS programming, stimulate learning and lead to an increase in STEM identity.

In this part of the interview, we are really interested in how the program impacted the engagement and interest of the individual students. We are not interviewing or talking to students directly but would like to ask you a few questions so we can try to determine any potential impact the program has to engage minoritized students.

Informed Consent:
As we have mentioned in previous interviews, your participation is optional and the notes from the interview will be stored and coded for use without any personally identifiable information. That means your identity will remain anonymous as much as we can protect it. Your comments will not be shared with your name or any other identifiable information. You can stop this interview at any time.
We have now provided an overview of the purpose of the study and consent for recording and participation; do you have any questions before continuing?

General building of rapport:
At this point, we have had the chance to get to know one another a little bit (*Consider retelling any anecdotal experiences from any of our observations or interviews previous to this one*). How was your summer with SEEDS overall? Do you think you will remain involved in STEM education in some way with children in the future? (*Ask some follow-up questions to clarify any answers shared. Make note of the instructors' answers and any details shared.)*

STEM Identity:

1. How do you define STEM identity? (*Test for instructor knowledge of the term we've shared previously and throughout the curriculum*)

2. How would you characterize the overall group of students' STEM identity now that the program and summer is over?
    a. Very small to zero STEM identity
    b. Small STEM identity
    c. Medium STEM identity
    d. Large STEM Identity
    e. Very Large STEM Identity

3. Tell me about an intern in the program who you feel showed growth in STEM?
    a. Did they also show growth in life skills, perseverance, problem solving skills, etc.?

STEM Interest

1. Why do you think students join the DIG program?

2. What do interns tell you they will be doing after they leave the DIG program?

3. What do you feel made the greatest impact on students this summer?

STEM Vision:

1. What do you envision when you envision a person working in STEM?

2. Tell me how interns learned about being good environmentalists and conservationists?

3. How does STEM have the ability to help students out of poverty?

4. Describe how students understand how AI/STEM education can improve equity in society.

Community Engagement/Impact

1. What does this community/neighborhood need to improve? (*Purposefully leave "improve" undefined and ask for their own interpretation)*

2. How does this program make a difference to the community? Please explain in as much detail as possible.

3. How would you adjust, or what would you add, to the program/SEEDS overall to better address the community's needs?

Appendix E

Data Analysis Protocol

TEAM DAD DATA ANALYSIS PROTOCOL*

Data Collected for Analysis:

- Pilot program observation notes for sessions observed on 8/2, 8/12, and 8/19.
- Transcripts and notes for pre and post pilot program interviews.
- Document analysis of organization website, logic models, budget details, and program information.

Protocol Overview

We will each use this protocol to analyze our own observation data and then to review the interview transcripts and notes. Keeping the study questions in the foreground, our first pass is individual analysis of data collected. Next, considering our theoretical and conceptual we will be interpreting the data to identify key thematic connections to existing literature or to identify areas that require supplemental literature review. Finally, we will take a systematic approach to analyzing the data comparing the study-team's data interpretations and to identify potential recommendations and findings all study team members agree upon. The potential recommendations and findings resulting from this protocol will have study-team researcher agreement as well as triangulation across multiple data collection methods.

Study Questions:

(1) Are community-led programs (SEEDS- DIG) focused on improving access and engagement with STEM topics helpful for the underserved youth population that SEEDS supports? What is the impact of community-led programs like SEEDS on improving access and engagement in STEM for the underserved students that SEEDS support?

(2) Will the availability of high-quality STEM curricular resources and technology support enable a community organization (SEEDS) to improve access and engagement with STEM topics for an underserved youth population?

(3) Will a DIG intern show deeper interest in STEM after the project? Are community STEM needs met by implementing a community-led program focused on improving access and engagement with STEM topics for the underserved youth population that SEEDS supports?

Theoretical and Conceptual Frameworks:

1) **Reflect** on the study question(s) being analyzed. Re-read the question(s) repeatedly as you complete the data analysis process for each step and stage. Consider the data collection protocols and previously identified themes as they relate to the study questions.

2) **Choose a data source and lay out the specific data points that source yielded.**

   a) We have 11 data sources- Observation #1, #2, & #3: Pre-Interview #1 & #2, Post Interview #1 & #2, Document #1, #2, #3, & #4.
   b) Use observation protocol notes, interview transcripts, and actual documents.
   c) Process in our Data Book excel file:
      i) Include observations (what did you see/hear?)
      ii) Include notes (what did you think?)
      iii) Identify any themes/key words

3) **Initial Findings.**
   a) Identify general patterns or trends independently as *Themes/keywords*
      i) No interpretation or evaluation of data at this point.
      ii) Simply name the facts or evidence that can be readily seen in the data and stated *without interpretation*. For example, reoccurring words or sentiments and ideas. We want what is empirically verifiable by observation of each data collection artifact we analyze.
      iii) Identify what can be observed by looking at these data by most persons.
      iv) Keep the observations factual:
         1. *I see…*
         2. *I observe…*
         3. *I notice…*

4) **Analysis to be done first pass independently and second pass together on Teams.**
   a) For deeper analysis, now we ask:
      (1) How do data sets (pre. post, observer 1 vs observer 2) compare to each other?
      (2) What are the commonalities among our observations/data analysis?
      (3) What patterns or similarities are evident across different data analysis findings?
      (4) What inconsistencies or discrepancies (if any) are evident?
      (5) What is not represented in the data?
      (6) What questions does the data raise?
   b) Capture the observations in list form in our Analysis Workbook.
   c) Capture questions in a separate column in our Analysis Workbook
   d) Continue until all team members have reported all observations.
      i) **Note**: During this step, it is acceptable to make observations based on those made by others in the group. Allow the process to proceed if logical and factual observations can be made.
      ii) **Note**: We must be vigilant to remain in observation stage before transition to the interpretation stage, clarifying when the group can begin to allow statements that may not be factually based.

5) **Interpretation to be done together on Teams**
   a) Now we review the entire list of observations together for researcher agreement and discussion.
   b) Finish coding (or grouping) the data into discernible chunks or categories (e.g., themes).
   c) Next apply our theoretical and conceptual framework to help dig beneath the surface of these data. This is the point of the data analysis process where we will start to draw conclusions, make inferences, and evaluate the significance of our findings.
   d) Other questions one might ask to facilitate interpretation include:
      i) What assumptions might be underneath what we are noticing in the data?
      ii) What clues help explain why a certain population is meeting or missing targets?
      iii) What areas in the data stand out needing further explanation?
      iv) What patterns or themes do we see in our observations?
      v) Which of these observations are most relevant and important to our inquiry?
      vi) Based on our observations, what do we know now?

6) **Extend the analysis together in Teams:** Return to our study questions and problem of practice.
   a) Consider responses to the following questions:
      i) What insights might our findings and interpretation of those findings be yielding?
      ii) What is the significance of our findings and interpretation?
      iii) What existing research helps support significance of the findings and interpretation?
      iv) What new questions or ideas need to be pursued or considered?
      v) And what possible conclusions or recommendations does our analysis provide?

      The questions may serve as the basis for another round of analysis, so it may be helpful to conclude by prioritizing them. Any conclusions will become the basis for subsequent action and recommendations to be included in the final report to our partner organization.

*This protocol is based on work presented by Nancy Love, author of "Using Data/Getting Results (2002)," who, in turn adapted it from Bruce Wellman's and Laura Lipton's "Data-Driven Dialogue (MiraVia LLC, 2004)." Additional questions adapted from Guide for Standard Bearer Schools: Focusing on Causes to Improve Student Achievement (2007). Community Training and Assistance Center (CTAC). Boston, MA.

Appendix F

Document Analysis

Website: https://www.seedsnc.org

OUR MISSION

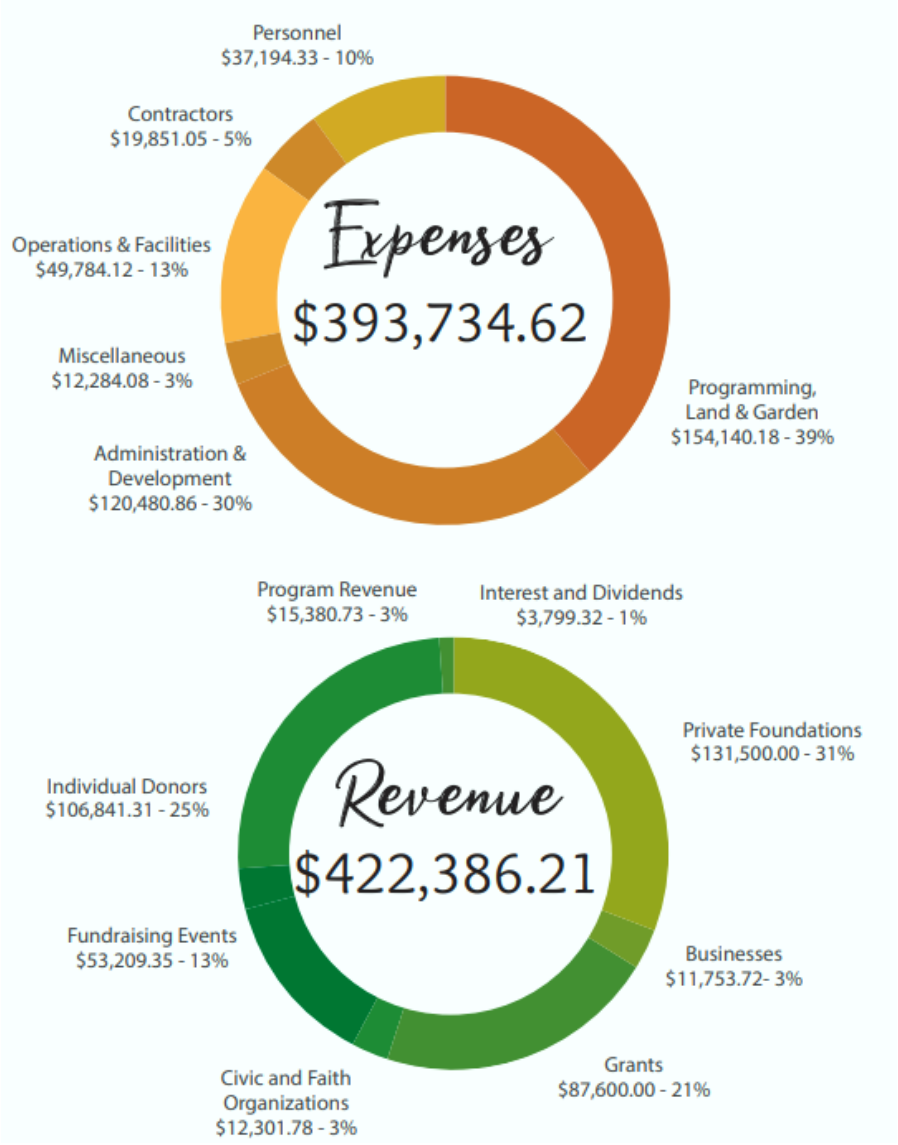
Founded in 1994, SEEDS is a two-acre urban garden and kitchen classroom in the heart of Durham. SEEDS develops the capacity of young people to respect life, the earth, and each other through growing, cooking, and sharing food.

Developing the capacity of young people includes responsibility, teamwork, leadership, environmental stewardship, equity, community, problem solving and experiential learning. Our whole-child educational programming incorporates growing, cooking and sharing food to help young people become resourceful and confident individuals with the capacity and commitment to be future leaders in their workplaces, their families, and their communities.

Appendix G

Document Analysis

Annual Report & Budget: https://www.seedsnc.org/wp-content/uploads/2019/11/Annual-Report-Master-File-18-19-FINAL.pdf



Appendix H

Document Analysis

FarmBeats Curriculum: https://learn.microsoft.com/en-us/training/educator-center/instructor-materials/farmbeats-for-students#comprehensive-educator-resources

Teacher Resources	Student Activities	Presentations & Scripts