

## **A Reflexive Thematic Analysis of the Experience of a High School Junior in the STEMcx Environmental Justice Internship**

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# **A Reflexive Thematic Analysis of the Experience of a High School Junior in the STEMcx Environmental Justice Internship**

## **Abstract**

This paper describes the impact of one student's experiences in a summer 2023 STEMcx Environmental Justice internship on their perceptions on environmental science and engineering through a reflexive thematic analysis of a semi-structured interview collected after the internship was completed. This summer internship was designed for high-school juniors and seniors in the Baltimore, MD area through STEMcx. The goal of STEMcx is to expand the number of African-Americans in science, engineering, mathematics, medicine, and technology (STEM) careers. The STEMcx Environmental Justice Internship is an 8-week experience that includes: independent research involving field measurements of particulate matter air pollution, career exploration, field trips and site visits, and a week-long college tour to the North Carolina Research Triangle area. The objective of the research described in this paper is to describe the impact of the Environmental Justice Internship on the ways this student perceives the trajectory towards environmental engineering careers. This inquiry is guided by this broad research question: "How does participation in environmental engineering and science experiences outside of the classroom contribute to the ways students construct early environmental engineering and science career trajectories?" This research is conceptualized as a qualitative study, grounded in a constructivist theoretical framework. We analyze the data we collected utilizing reflexive thematic analysis methodology. By carefully exploring the ways that this participant describes their experiences in this internship—including their judgments, actions, challenges, obstacles, and accomplishments—we will provide insight into the role of out-of-school experiences in students' entry to environmental science and engineering.

## **Introduction**

This paper describes the impact of one Black male student's experiences in the summer 2023 STEMcx Environmental Justice internship on his perceptions of environmental science and engineering through a reflexive thematic analysis of a semi-structured interview collected after the internship was completed. The overall objective of the larger project in which this work is situated is to expose Black and under-represented high school students to the exciting, interdisciplinary field of environmental engineering and science through the lens of environmental justice. It is clear that pre-college out-of-school experiences with engineering increase students' likelihood of entry to engineering majors (Godwin et al., 2016). However, many Black and underrepresented students do not obtain exposure to these fields in meaningful out-of-classroom experiences.

The representation challenges for Black and underrepresented students in STEM fields has been well-documented and will not be recited here. Suffice it to say that programs similar to the STEMcx Environmental Justice internship have implications for persistence in STEM (Graham et al., 2013), pathways into engineering (Godwin & Kirn, 2020; Kirn & Benson, 2018), and self-efficacy (Newton et al., 2020). Rather, to motivate this research I rely on three anecdotal observations I made during the 2022 pilot of the STEMcx Environmental Justice Internship. These anecdotes will make clear the critical need for phenomenological exploration of the experiences of Black and underrepresented students in out-of-classroom engineering and science internships and other pre-college work experiences.

During the summer 2022 pilot environmental justice internship cohort, I had many opportunities to engage with the interns in informal conversations about a range of topics. Since most of the 2022 cohort were women (5 out of 6), there were a range of opportunities to talk informally about gender roles. For example, one day the women were joking about the way the young man in the group would walk into the meeting after his football practice—he was also the youngest student—and I told them not to pick on him since he’s the only “young brother” in the group. They quipped that it’s good for the situation to be reversed, for once, and for them not to be the only one among a group predominantly composed of men. We were able to discuss how this has been an obstacle to their pursuit of a variety of science and mathematics courses or experiences, and how this internship was refreshing for them to participate among a group predominantly composed of black women.

A second anecdote from the 2022 pilot involves students’ perception of environmental justice career paths. One student remarked that as a result of the internship, they might no longer consider environmental science as a possible career path. They thought that the data collection, data management, and data analysis experiences indicated that the career path might not be something they were interested in. On the one hand, this could be an artifact of the way the internship was programmed. For some students with little or no experience with programming, statistics, or field work, the program may not have been designed with enough support. This may have affected this particular intern’s confidence and self-agency with the tools and tasks used, and they may have imputed their difficulties to future study and work experience. On the other hand, this anecdote refutes the common assumption that students who participate in similar programs are more likely to possess a STEM identity. Most of these 6 students did not possess a STEM identity, and found themselves in the program as the result of a range of factors aside from their own personal interest. We need better insight into how students who do not have STEM identities experience programs intended to broaden participation in STEM.

A final anecdote from the 2022 pilot occurred when the instructor was introducing the interns to scientific poster presentations in advance of their poster session and awards presentation. On the slides, I attempted to select images of poster sessions that included diverse scientists—at least on the basis of surface characteristics such as skin color and gender appearance—but this highlighted for the students that not only had they not seen or participated in such an event before, but that even the pictures selected seemed to reinforce that black women and men are minorities in US STEM communities.

Many more anecdotes can be drawn in order to justify the need for a rigorous, phenomenological exploration of the role of the STEMcx and similar programs in a high school student’s career trajectory and professional identity formation. These in particular highlight the need for deeper insight into how the design of similar experiences should be informed by the needs of diverse students entering STEM career pathways. Although our analysis includes data from one student semi-structured interview, our findings may prove useful in providing criteria that will guide the design of internships and STEM experiences aimed at increasing the number of African-American men and women on pathways to STEM careers.

## **Research Questions**

The overall research question explored in this work is, “What is the impact of the STEMcx environmental justice internship on its participants’ construction of their early environmental engineering and science career trajectories?” This research question involves a component

related to exposure to the career opportunities in environmental engineering and science, and also a component involving the ways the actual work done influences students' perception of their preparation.

- **RQ1:** How does participation in environmental engineering and science experiences outside of the classroom contribute to the ways students construct early career trajectories?
- **RQ2:** How does participation in environmental engineering and science experiences outside of traditional classrooms influence students' perception of their preparation to construct and participate in professional judgment processes?

## **Background**

### *Overview of the STEMcx Environmental Justice Experience*

This data analyzed in this research reflects the experiences of one intern in the STEMcx Environmental Justice Internship. STEMcx is an organization seeking to change the representation of Blacks and Hispanics in the STEM workforce with a bachelor's degree or higher <stemcx.org> by engaging underrepresented populations in STEM engagement activities including book clubs, tutoring programs, internship programs, and a conference and exposition. It is important at this point to indicate that the STEMcx organization was conceptualized by, and is currently directed by individuals with extensive industry expertise in the areas of systems engineering and control systems engineering. Although some of the elements of the STEMcx programming do not resemble the types of tasks practicing engineers may engage in (e.g., poster sessions, laboratory work), these tasks are common in academia where the students will need to be successful en route to successful entry to the engineering and science professions. Moreover, all STEMcx internship programs include industry participation and exposure. The primary objective of these programs is to foster awareness among underrepresented student groups of what a range of STEM careers look like, and what is necessary to enter those careers.

The Environmental Justice internship is a multi-component experience designed to introduce students to the field of environmental engineering through the lens of social justice reflected in the multiple disciplines comprising the field of environmental justice. The internship includes: i) field trips to manufacturing facilities, EPA facilities, regulatory air pollution monitoring sites, and community organizations involved in the pursuit of environmental justice; ii) external presentations by environmental justice experts, practitioners, and government representatives including the Secretary of the Maryland Department of the Environment; and iii) an independent research component involving collection and analysis of field air pollution measurements using low-cost sensors and the R statistical programming language. During the summer 2023 cohort, the internship was designed to average 10-20 hours of student engagement per week. I was the lead instructor for the research component of the internship. The environmental justice internship engaged eight (8) 11<sup>th</sup> grade interns to participate in discourse at the intersection of the arts, engineering, technology, policy, and public engagement. Most of these students do not possess strong STEM identities, and the majority of the students who participated in the environmental justice internship did not intend to pursue STEM, environmental engineering, or environmental science career trajectories.

## *Participant*

In this paper, I will refer to the participant whose experience is the subject of this paper as Malik. This is a pseudonym chosen to preserve confidentiality, yet prioritize his voice in the results section. I have also chosen a pseudonym that I feel represents a broad range of African-American experiences (Malik means “king”, a common name of greeting among Black men) yet would allow the reader to engage with the participant’s experiences in a more subjective, personal way. Malik is an African-American man who was entering his 12<sup>th</sup> grade year in high school when he participated in this semi-structured interview. Malik describes his ethnic background as Afro-Latino. When he participated in the STEMcx internship, he was just completing his junior year. He attends a well-known private high school in the Baltimore, MD area, but did not describe his socio-economic status for this research. His high school is split between two single-sex campuses (e.g., men and women have separate campuses) with the option for students to take some high school courses on either campus regardless of gender. His high school offers higher level AP courses (women’s campus) and IB courses (men’s campus). When asked about other experiences or resources he participated in at his high school, Malik did not describe STEM or environmental justice based extracurricular activities. Instead, the participant expressed a clear interest in studying biology in college, and has a strong interest in what he called “practical philosophy” and a love of knowledge. He has sought out leadership positions at his high school that align with his interests in philosophy.

## **Methods and Assumptions**

### *Research Orientation and Worldview*

This work is inspired by a transformative worldview (Charmaz, 2014; Creswell & Plano Clark, 2017) that is informed by my interpretations of conscientiz o (Freire, 2000) and consciencism (Nkrumah, 2009). The transformative worldview asserts that people must be awakened to the realities around them to then act on this reality as intelligent subjects. As Charmaz (2014) writes, it is “situated in conceptions of justice and injustice”. For example, in discussing the role of conscientiz o in revolutionary leadership, Friere writes (p.67):

The revolutionary leaders must realize that their own conviction of the necessity for struggle (an indispensable dimension of revolutionary wisdom) was not given to them by anyone else—if it is authentic. This conviction cannot be packaged and sold; it is reached, rather, by means of a totality of reflection and action. Only the leaders’ own involvement in reality, within an historical situation, led them to criticize this situation and wish to change it.

Here, you can see Friere’s emphasis on reflection, involvement, and action. In his writing, anything less than co-participation in this type of reflective action dehumanizes people and proscribes their liberation. Similarly, Nkrumah writes (p.79):

...philosophical consciencism is the map in intellectual terms of the disposition of forces which will enable African society to digest the Western and the Islamic and the Euro-Christian elements in Africa, and develop them in such a way that they fit into the African personality. [...] Philosophical consciencism is that philosophical standpoint which, taking its start from the present content of the African conscience, indicates the way in which progress is forged out of the conflict in that conscience.

His goal is to present a philosophy of intellectual revolution in which one’s thinking or philosophy is directed towards the redemption of society. He wrote with the goal of presenting a philosophical worldview that would enable African societies to assimilate and develop Western,

Islamic, and Euro-Christian elements into the African context. Again, the goal is a reflective transformation of society.

I adopt this orientation, which I will call by the English transliteration of Friere's term, conscientization, in order to center the experiences and voices of Black and under-represented students who reflect on the cultural and institutional factors that influence their experiences and transform those experiences to meet their own personal or social objectives. My orientation goes beyond rejecting the deficit framing that many recent investigators have also rejected (e.g., Tolbert Smith (2022)) or adopting a growth mindset or deconstructing "smartness" (e.g., Dringenberg et al. (2022)). This worldview concords with the historical development of environmental justice as a substantially critical and transformative perspective situated within environmental engineering, environmental health, and related fields. Additionally, my goal is not just to understand how Black and under-represented students endeavor to transform their own circumstances, my goal is also to help them develop the tools they will need to transform their own futures, professions, and communities.

### *Theoretical Framework*

This work is situated within the constructivist theoretical framework. Corbin and Strauss (2008) describe the constructivist framework as one where researchers construct concepts and theories from accounts that are constructed by participants from their own experiences. Creswell and Plano Clark (2017) note that this will imply research being shaped "from the bottom up" via participants' individual perspectives and experiences. As these perspectives and experiences are analyzed and evaluated by researchers, these individual experiences yield to broad patterns and understandings. Consequently, I summarize Creswell and Plano Clark's view of the constructivist framework for this work as focused on understanding through the observation of participants' meanings for the purpose of exploratory theme generation.

### *Researcher Positionality*

I am an African-American male systems engineering professor who is passionate about introducing pre-college students to the multidisciplinary fields of environmental science and environmental systems engineering. I am especially interested in exploring how underrepresented pre-college students are impacted by programs such as STEMcx. Additionally, I have attended the church that provides the institutional support for the nonprofit organization where STEMcx is housed, and my son has attended STEMcx elementary school programs in Scratch coding, lawn rocket launches, and STEM fiction book clubs. The author's long-term goal is to use out-of-classroom engineering and science experiences to understand how students develop the professional skills required to participate in engineering judgments. Moreover, environmental science and engineering require contributions from professionals in environmental science, systems sciences, data science, computer or mechanical engineering, and public health, yet many individuals who are not active in environmental science and engineering often do not realize the multiple avenues of participation in environmental science and engineering. Moreover, I was initially excited to pursue environmental engineering as my undergraduate major after one of my professors, Dr. Kimberly Jones of Howard University, explained the field of environmental justice to me. I have chosen to use the first-person singular pronoun in this paper to emphasize the fact that I am both researcher and instructor in this context, and the STEMcx internship experience also transformative for me. I am influenced and shaped by my interactions with the interns—and my reflection on the conversations I have had

with them in the focus group, semi-structured interviews, and throughout the program—such that I believe it is inappropriate to write in the third-person for the appearance of objectivity when there is none possible.

#### *Data Collection.*

To explore our research questions, I solicited the participation of each of the interns in both a focus group during the last in-person meeting of the internship and an individual semi-structured interview conducted virtually after the internship was completed. The Environmental Justice internship included 8 high school juniors from the Baltimore area, including 4 women and 4 men. All 8 students participated in the focus group conducted at the end of the internship, and one male and one female intern were also individually interviewed. This paper presents the analysis of the male student's semi-structured interview. Although the focus group and individual interviews were semi-structured, they both involved two parts: i) questions related to the impact of the internship on career trajectory; and, ii) questions related to the design and implementation of project work during the internship. The individual interview protocol questions used in both individual interviews are provided in the Appendix section at the end of this article. In the first part, prompts focused on interns' professional goals and interests, high school academic environment, formulation of career pathways, influences and sources of information, and other factors that influence career direction and professional identity development. In the second part, prompts focused on the students' experiences while completing their projects, including influences of presentations and site visits, research design choices, obstacles, improvisation, or planning engaged to overcome obstacles or take advantage of emerging opportunities, communication practices, interactions among interns and instructors, and other factors that relate to the ways engineering practice was enacted throughout the internship. Other data influencing the interpretation of the interview data include my field notes, unstructured observation of student work processes, and informal conversations between the STEMcx Director and myself throughout the program.

#### *Data Analysis*

The data were analyzed using reflexive thematic analysis. According to Braun and Clarke (2021), reflexive thematic analysis is “a method for identifying, analyzing, and reporting themes within data.” Reflexive thematic analysis is flexible and can be adapted to a range of theoretical frameworks and can facilitate development of a detailed, complex account of the dataset. The data were analyzed by myself alone. The first step in the process involved obtaining an intelligent verbatim transcript of the two semi-structured interviews and checking the accuracy of each transcript against the original audio files for both. Transcripts were completed using a third-party service (GoTranscript.com) from the .mp4 audio file created during the Zoom semi-structured interview session with each student. After checking the transcripts, names of intern participants were removed from the original transcripts.

Coding and theme identification involved a three-step process involving *in-vivo* coding, dramaturgical grouping, and thematic mapping. First, the interview was coded using an *in vivo* approach. I would identify phrases or key words in the original data that represented the main idea or thought of the paragraph or sentence. Only data items relevant to the research questions were coded. I chose an *in vivo* approach in favor of a preliminary codebook to utilize an emergent coding method that prioritized Malik's voice. The *in vivo* coding was completed in Atlas.ti 9, and the list of *in vivo* codes was exported to an Excel file for further analysis. After the

*in vivo* coding of the interview was completed, I used dramaturgical strategy code groupings (Saldana, 2016) to construct initial groupings of the *in vivo* codes and begin to construct a narrative around the ways Malik revealed his perception of how this internship and his prior experiences prepared him for a career in STEM. Six strategy code groupings were utilized: (OBJ) participant-actor objectives; (CON) conflicts or obstacles confronted by the participant-actor keeping them from achieving their objectives; (TAC) participant-actor tactics or strategies to deal with conflicts or obstacles; (ATT) participant-actor attitudes towards setting, others, and the conflicts; (EMO) emotions experienced by the participant-actor; (SUB) subtexts, the participant-actor's unspoken thoughts or impression management; and (OTHER) important contextual elements that do not fit the other six groups. After reviewing these groupings, I manually constructed a thematic map from the *in vivo* codes. The dramaturgical grouping and thematic mapping facilitated a deep familiarity with the inter-weaving narratives Malik expressed during the interview that helped to construct inter-relationships among the various *in vivo* codes created during the first step. This thematic map was then utilized to construct the three themes reported in the next section.

## Analysis

### *Theme 1: "Everything was Different"*

Throughout the interview, it became clear that one novel understanding Malik was realizing about the professional trajectories of environmental scientists and engineers is the fact that research processes, including experimental planning, field data collection, data analysis, and interpretation involve surprises. On the one hand, Malik shared the common expectation that STEM professionals work with data, but on the other hand, Malik felt that data should speak for themselves:

Then the data is just going to talk for itself, but ended up having the data come back and everything was fully different.

Most STEM practitioners would concur that data do not, in fact, speak for themselves. However, this understanding is developed through experience interpreting data and using them to communicate persuasively in disciplinary contexts. Many high-school students do not have this experience. Rather, much of their experience with data collection and analysis may involve considerable structure and scaffolding, so that the degree to which one might be surprised by their results is limited. In fact, it is possible that being surprised by data and their interpretation may lead a student to believe they have done something incorrectly.

This is echoed, in part, by the way Malik was surprised by the magnitude of the air pollution concentrations he collected. Part of the reason he designed the project he and his partner designed was due to their experiences in their community with the perceived pollution source, Wheelabrator Incinerator:

Because I had already known of there being this big plume right into Baltimore. It always confused me or got my attention. I remember asking my mom what it was. She just said that's where they incinerate trash at but a whole bunch of smoke coming out of a big plume, it didn't really just sit right with me. It always felt alarming.

In Baltimore where our work is situated, Wheelabrator is prominently situated just off of the MD-295 entry into the city. This area of the city also houses the Greyhound bus terminal, sports stadiums, casino, and entry points to the I-95 and I-895 Inner Harbor tunnels. It is impossible to miss, and is clearly salient to Malik. During the internship, one of the presentations made by



practitioners and activists was given by Destiny Watford, winner of the 2016 Goldman Environmental Prize (Foundation, 2024). Ms. Watford described her experiences fighting against this incinerator and her activism is largely responsible for its installation of updated technologies. This presentation left an impression on Malik. He is passionate about protecting people and community interests related to environmental justice, as opposed to the interests of “money-hungry corporations”:

My role is really just to keep a clean community out of the way from the impedances of, I guess, money-hungry corporations who prioritize money over human health, which I saw a lot of during this internship.

All of these factors combined to lead Malik to believe that placing air pollution sensors in the neighborhood near this location would uncover large pollution amounts:

In terms of Pig Town, Washington Village, where my mom's shop was at, I thought the data was going to be much higher, much worse because it was right there, really like two, three minutes away from the Wheelabrator incinerator so I was like, "All right, this is going to be nice. I'm going to put one right here, one right there, one right there."

Thus, he was surprised when he collected the data and noticed that the freight train that passed his home caused a bigger signal than the incinerator:

It was weird because I looked at Lakewood and Lakewood wasn't the same. It was huge spikes for my freight train coming out of nowhere into the most unhealthy levels that I saw out of all data. I think the biggest challenge was having to analyze that data and understand why it came out the way which it did and be able to explain the data.

This helped him to understand how important it was to explain the data. Data do not, in fact, speak for themselves.

This theme indicates how important out-of-classroom experiences can be in students' conceptions of their future career trajectories in STEM. Many students will not have opportunities to struggle with the design of their own projects and data collection in unstructured environments characterized by ambiguity. Moreover, they will have limited opportunities to wrestle with the unexpected. It is possible that Malik's experience dealing with unexpected findings will become part of his repertoire and contribute to his ability to persist when faced with unexpected results that could potentially cause students to question their capabilities.

### *Theme 2: "Taking That Initiative, Taking That Action"*

The interview indicated Malik placed a heavy emphasis on leadership skills and experience. He clearly, and emphatically, views leadership and personal initiative as critical to his evolving trajectory. His conception of his future career trajectory involves a proactive orientation towards knowledge acquisition and “making things happen” in team projects.

This value placed on leadership was brought to the internship, and not necessarily awakened by it. For example, the interview shows that his high school extracurricular experiences all focused on either practical philosophy, knowledge acquisition, or leadership experiences, not athletics:

I think in terms of my leadership activities, I believe that it'll cause me to-- I think that it'll only really cause impacts in terms of extracurriculars. For example, I'll probably apply for a few leadership opportunities at the secondary institution that I ended up going to. In terms of Black Awareness Club, I'll definitely, if I can, get into a program at that institution that I end up maybe getting into, just for the advocacy of Black people and all that type of stuff. I think with my other club-- What other club do I have? Practical philosophy, I just really like knowledge. I like just listening to stuff, learning about new things. I think practical philosophy, looking at different ways of life and all that other stuff. I think it's not only to show that I want to learn and that I want to go into maybe even an extracurricular such as practical philosophy in the future.

At the same time, Malik expresses some awareness of the cost of academic ambition, describing some of the factors affecting his decision whether to pursue IB (international baccalaureate higher level, HL or standard, SL) or AP (advanced placement) courses at his high school as including stress:

I decided not to take three HLs as I saw that it was very stressful for a lot of people and just a whole bunch of extra work, really, for just same, really, GPA. I'm pretty sure HLs don't even boost your grade that much higher but it just looks cool. I just didn't think it was worth all the stress. I decided to only go for one HL last year that I thought I would like, which was psychology. Now I'm into two HLs this year, which is psychology and history.

This view is held in tension with his consideration of biology as a major in college, and the importance of hard work to success in his future to majoring in biology:

I guess the higher standard that I'm held up to at school which causes me to produce, I think, a better work ethic or just a stronger work ethic, that will prepare me for biology, a topic that I know, or a major, which I know and is known to be a little bit more strenuous.

And:

I've just heard people say it. I've just heard people say that it's strenuous just as I've heard other people at my school say that certain courses, which I'm taking right now, are strenuous. Just with the information that I have right now, I believe that I'm getting well prepared, but I'm not sure which levels of strenuous they both stand on. However, there's only so much I could do right now to prepare myself in terms of work ethic for that course. I think I'm doing my best in doing so.

While stress was mentioned as a concern, this is clearly juxtaposed with Malik's willingness, even desire, to work strenuously for achievement in STEM if he were to choose that route. He noted that he "really like[s] knowledge", yet one can argue from the larger corpus of data that he is primarily interested in knowledge that leads to action.

While Malik's leadership aptitude was brought with him to the internship, the internship certainly foregrounded this dimension to his personality. On one occasion, I was talking with Malik and one other participant in the course of reviewing project progress. Malik referred to the other student as a "nerd". At that point, I chose to ask Malik whether he himself identified as a nerd. When he indicated that he did not, I listed many of the behaviors he exhibited in the internship: he was often the first one to try out the technology when I instructed the students to test the devices at home; he always submitted assignments early in the process to receive feedback; he was on time for most sessions; he participated thoughtfully in our discussions and took notes; and he was always attentive at site visits and internship programming asking enthusiastic questions and engaging with the presenter(s). We both agreed that he exhibited the behavior of a "nerd", even though he did not want to identify as one. This anecdote illustrates the potential for the internship to highlight and affirm the strengths a student possesses, in ways that help them to connect their personal attributes to a professional trajectory.

Moreover, Malik's accounts of his project work alongside his partner further illustrate his positive attitude towards leadership and engagement. For example, when asked about how he viewed his team's dynamic in light of the role of teamwork in science and engineering, he re-cast the question in terms of leadership in light of the fact that he was clearly aware of some potentially negative experiences in the other intern teams:

I didn't have a huge issue with this. I say that because I know a lot of people probably would. [My partner] wasn't really very immediate with the things that he did in the procedure and all that, but that wasn't really anything bad to me as I had decided to lead things a few times. I think in terms of dynamics, I would say I

was the leader of the group. I'd say he was a really good-- I don't know, I think associate or-- Not associate because he worked. It was as if-- I don't know. We were both in leadership positions as we had to lead the project and all that. I'd say I was the president, he's the vice president. [My partner] still did his thing though. [My partner] definitely did his thing. I did my thing. We both did our thing and we made things work.

This suggests that Malik views one reason for lack of success in teamwork is a lack of leadership. Additionally, he re-interprets his experience by framing his—and his teammate's ["we were both in leadership roles"]—experience as a team leader. In order to get things done, it requires leadership. Therefore, both he and his teammate must take on leadership roles in order to achieve their goals and complete their work. Malik's internship work and interview highlighted the degree to which he believes a successful individual has to take initiative in science, thereby affirming a preconceived impression he possessed prior to the internship. Although he possessed this interest beforehand, the internship affirmed this characteristic in Malik and potentially confirmed its contribution to his understanding of his own professional trajectory:

I already knew this, but it came out a little bit more during the internship, but you're going to have partners just in life and those work partners you can't always rely on them 100% to do what you've planned for them to do or is planned to get done. You got to take that role in making sure that things get done, when that role needs to be filled, and when things need to get done, and you don't see them getting done. Just taking that initiative, taking that action, making sure that things get done is what I would say I was taught a little bit more from this internship.

### *Theme 3: "More Professions than I'd Imagined"*

A third theme involves the new understanding Malik has developed around the number of ways one can enter environmental engineering. Although Malik is not interested in becoming an environmental engineer, he felt the internship was "not a waste of time" and helped him understand the range of professions involved in environmental justice:

Environmental justice it's the focus on an environment and its issues in terms of people, quality of life, just all aspects of an environment and not only focusing on issues, but solutions in which there are to solve such issues and improve quality of life and the environment for the better of the species or the better of the environment.

Malik became more strongly aware that environmental justice—and by extension environmental engineering and science—is not just about problems, it is about finding solutions. Therefore, these fields are not just about activism. They engage all aspects of the environment. Along with that, one must pursue fields that provide insight into every aspect of the environment, every aspect of the community, various aspects of business and politics that influence environmental and community outcomes, and even the arts. All of these areas were incorporated into the structure of the broader STEMcx Environmental Justice internship. While environmental justice does in fact include advocacy, Malik's experience was broadened well beyond this initial understanding of what the field was in order to draw on these various areas of expertise and experience not just to identify issues, but most importantly to synthesize and promote solutions.

Where environmental justice does involve advocacy, it involves a diversity of types of advocacy work. Malik was especially impressed by his visit to the EPA where the presenters explored the range of environmental justice related fields.:

It revealed to me that there were a lot of ways to get into environmental science, a whole lot of ways. Just in terms of advocacy, which is just its own thing in environmental science, environmental science advocate, you could advocate in so many different ways, from dancing to singing to plays to-- It's just so

many different ways that you could advocate for environmental justice and I guess just a lot of other things, but environmental justice there's--You could get in through engineering. Firefighter, you don't have to just come in as, I guess-- I don't know, an advocate or somebody who wants the air to get clean or whatever. Stuff like that. You could be a professor, you could be-- You could work at the Environmental Protection Agency. The Environmental Protection Agency has a whole bunch of different departments within it. Being that there are that many different jobs that you could have. I think going to the Environmental Protection Agency, seeing all those different things that you could do, I think that was the most important best show of how many different careers that there are within it.

This is among the most powerful impacts of the STEMcx internship: students who participate are exposed to a broad diversity of professional career paths and practitioners. This is so important, because both this interview and the broader literature suggest these personal experiences and relationships largely shape what students believe are possible professional futures for themselves (London et al., 2021). While on the one hand, representation is important, it is potentially more important to help students to become aware of the constellations of communities of practice that intersect in their interest areas. Many of these communities of practice may not be clearly described or discussed in pre-college education, and many students may not have access to networks involving a diverse range of STEM professionals.

These types of experiences can also help students to draw connections across potentially disparate professional communities or bodies of knowledge. This theme shows that the types of interdisciplinary experiences involved in internships such as the STEMcx environmental justice internship provide intensive, situated exposure to the ways that solving complex problems faced in science, industry, and communities require contributions from several different fields. This intensive exposure could help students to construct a scaffolding that could be used in the future to situate classroom knowledge that has traditionally served as “weed-out” classes. This weed-out effect has been observed as more negative to students who have not had out-of classroom experiences to help contextualize the knowledge they are learning.

### **Concluding Thoughts**

This exploration provides deep insight into the intersection between one participant’s experiences in the STEMcx Environmental Justice internship and his perception of his career trajectory. This inquiry highlights the importance of developing out-of-school, authentic STEM experiences for future engineering professionals, as students may not have access to experiences that provide the depth and breadth they may need to stimulate thinking about their future possible selves. Moreover, while students use a range of resources and assets at their disposal to decide what their future may look like, this study demonstrated that experiences similar to the Environmental Justice internship that Kareem experienced can help students wrestle with similar ambiguities, uncertainties, and professional challenges they might see in college or their future careers. This experience may also help to support the development of robust STEM identities (McGee, 2015).

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## **Appendix: STEMcx Individual Interview Protocol**

### **STEMcx Individual Interview Protocol**

The interviews with individual interns will follow a semi-structured format using the questions below as a guiding framework. The language will be similar to the phrasing below, but exact wording may change to follow the flow of conversation and/or clarify questions as necessary. Points under each question indicate the kinds of prompts that will be used for follow-up questions. The interview protocol is designed for the interview to take approximately 30-60 minutes, and result in between 20-45 minutes of recorded and transcribed length.

#### Demographic information:

I'd like to begin by getting a little bit of information about you:

What year of schooling are you entering in 2023-2024?

How would you describe your ethnic or racial background?

What is your gender?

What high school do you attend?

Does your high school have advanced courses in mathematics and science? (e.g., Does your high school have AP, IB, or similar designation in courses such as physics, chemistry, biology, or calculus?)

Are you considering a STEM/STEAM major in college? Describe how you believe your high school will prepare you for this major.

What types of extra-curricular activities do you participate in at your school?

Aside from school, what other significant influences help to envision and prepare you for your academic or professional careers?

**We're trying to understand the influence of STEMcx programs on interns' future career plans. I want to ask you a couple questions related to your participation in the environmental justice internship and how it potentially intersects with your future plans**

#### Questions related to environmental justice:

First, I want to ask about your understanding of environmental justice:

- What is environmental justice?
- What is your role in achieving environmental justice in your current or future communities?

#### Questions related to project work:

Next, I want to ask you about the project you completed for the internship:

- What was your project's overall objective or hypothesis?
  - Describe why you chose this hypothesis. What observations, experiences, or data led you to select this research objective or hypothesis?
- Please describe the methods of data collection and analysis you used to complete your project and achieve your objective.
- Please describe a challenge or obstacle you faced in this project. How did you overcome it?

Questions related to future careers:

Next, I want to ask you about how your experience relates to your future plans:

- What did this internship reveal to you about careers and opportunities in environmental justice?
- What did this internship reveal to you about careers and opportunities in STEM fields?
- How did this internship influence your ability to participate in STEM fields and environmental justice careers?

Conclusions:

Are there any questions I didn't ask related to environmental justice, environmental careers, or STEM careers that I didn't ask that I should have asked?

Thank you so much for your time and participation in this study.

## References

- Braun, V., & Clarke, V. (2021). *Thematic Analysis: A Practical Guide*. SAGE Publications, Ltd.
- Charmaz, K. (2014). *Constructing Grounded Theory* (2nd ed.). Sage.
- Corbin, J., & Strauss, A. (2008). *Basics of Qualitative Research (3rd ed.): Techniques and Procedures for Developing Grounded Theory* <https://doi.org/10.4135/9781452230153>
- Creswell, J. W., & Plano Clark, V. L. (2017). *Designing and Conducting Mixed Methods Research*. SAGE Publications, Inc.
- Dringenberg, E., Kramer, A., & Betz, A. R. (2022). Smartness in engineering: Beliefs of undergraduate engineering students. *Journal of Engineering Education*, 111(3), 575-594. <https://doi.org/https://doi.org/10.1002/jee.20463>
- Foundation, G. E. (2024). 2016 Goldman Prize Winner: Destiny Watford, Environmental Justice. <https://www.goldmanprize.org/recipient/destiny-watford/#recipient-bio>
- Freire, P. (2000). *Pedagogy of the Oppressed* (30th Anniv ed.). Continuum.
- Godwin, A., & Kirn, A. (2020). Identity-based motivation: Connections between first-year students' engineering role identities and future-time perspectives. *Journal of Engineering Education*, 109(3), 362-383. <https://doi.org/10.1002/jee.20324>
- Godwin, A., Sonnert, G., & Sadler, P. M. (2016). Disciplinary differences in out-of-school high school science experiences and influence on students' engineering choices. *Journal of Pre-College Engineering Education Research (J-PEER)*, 6(2), 25-38. <https://doi.org/https://doi.org/10.7771/2157-9288.1131>
- Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A.-B., & Handelsman, J. (2013). Increasing persistence of college students in STEM. *Science*, 341, 1455-1456.
- Kirn, A., & Benson, L. (2018). Engineering Students' Perceptions of Problem Solving and Their Future. *Journal of Engineering Education*, 107(1), 87-112. <https://doi.org/10.1002/jee.20190>
- London, J. S., Lee, W. C., & Hawkins Ash, C. D. (2021). Potential engineers: A systematic literature review exploring Black children's access to and experiences with STEM. *Journal of Engineering Education*, 110(4), 1003-1026. <https://doi.org/10.1002/jee.20426>
- McGee, E. O. (2015). Robust and Fragile Mathematical Identities: A Framework for Exploring Racialized Experiences and High Achievement Among Black College Students. *Journal for Research in Mathematics Education*, 46(5), 599-625. <https://www.jstor.org/stable/10.5951/jresemetheduc.46.5.0599>
- Newton, K. J., Leonard, J., Buss, A., Wright, C. G., & Barnes-Johnson, J. (2020). Informal STEM: learning with robotics and game design in an urban context. *Journal of Research on Technology in Education*, 52(2), 129-147. <https://doi.org/10.1080/15391523.2020.1713263>
- Nkrumah, K. (2009). *Consciencism*
- Philosophy and Ideology for De-Colonization and Development with particular reference to the African Revolution*. NYU Press. <http://www.jstor.org/stable/j.ctvwrm4jh>

- Saldana, J. (2016). *The Coding Manual for Qualitative Researchers* | SAGE Publications Inc (3rd Editio ed.). SAGE Publications Inc. <https://us.sagepub.com/en-us/nam/the-coding-manual-for-qualitative-researchers/book243616>
- Tolbert Smith, D. (2022). "They are here to support me": Community cultural wealth assets and precollege experiences of undergraduate Black men in engineering. *Journal of Engineering Education*. <https://doi.org/10.1002/jee.20480>