

Article

Community Cultural Wealth and Science, Technology, Engineering, and Mathematics (STEM) Identities as Motivators for Black Boys to Participate in a High School Academy of Engineering

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Abstract: Researchers have emphasized how the high school STEM-themed career academy model benefits ethnically and racially diverse learners by promoting positive STEM identities and raising the interest of students to pursue STEM college and career pathways. The purpose of this study was to examine the reasons why Black boys participated in a high school academy of engineering. We were also interested in identifying academy features that helped promote (or inhibit) positive STEM identities among Black male students. In this qualitative study, we used data from 17 Black male high school academy of engineering students. We analyzed the interview transcripts using a constant comparative method. Using an embedded case study approach, we compared our findings to the community cultural wealth (CCW) factors and the factors that researchers have found to influence students' STEM identities. We found that the participants brought six forms of capital with them that served as sources of motivation to participate in the program. The forms of capital that were related to the CCW framework included aspirational, familial, navigational, resistance, and social. While we did not uncover linguistic capital in our data analysis, we did find an additional source of capital that was not reflected in the CCW framework. We found that the Black boys had natural STEM talent based on the formation of STEM identities. The students had high aptitudes in STEM-related subjects, and they were engaged by participating in hands-on activities. We recommend that schools integrate STEM curricula for Black boys and provide Black men to serve as STEM role models through guest speaking opportunities, job shadowing, mentoring, internships, and other work-based learning experiences.

Keywords: Black boys; community cultural wealth; high school; STEM academies; STEM identity



Citation: Fletcher Jr., E.C.; Carroll, T.K. Community Cultural Wealth and Science, Technology, Engineering, and Mathematics (STEM) Identities as Motivators for Black Boys to Participate in a High School Academy of Engineering. *Educ. Sci.* **2024**, *14*, 873. <https://doi.org/10.3390/educsci14080873>

Academic Editors: Virginia Snodgrass Rangel, Jerrod Henderson and Daniel Burleson

Received: 31 May 2024

Revised: 3 August 2024

Accepted: 8 August 2024

Published: 10 August 2024



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1. Introduction

Researchers have found that many Black boys in K-12 do not identify themselves with Science, Technology, Engineering, and Mathematics (STEM) fields [1,2]. The high school level is a critical point where students begin to demonstrate interest and motivation for STEM [3]. For decades, scholars have argued that pre-collegiate academic preparation is a key factor in Black students' decisions and abilities to successfully pursue STEM degrees [4–6]. Researchers have found that particular learning environments and programs (e.g., high school STEM academies) enhance student engagement and promote interest in STEM for Black boys because of the hands-on content and the heightened support from engaging in a small learning community [7].

Researchers have identified STEM informal and formal pre-college programs as contributing factors in developing learners' STEM identities [1,2,8]. For example, STEM summer camps may offer hands-on opportunities to practice STEM, helping learners see

themselves as people who can do well in STEM. STEM career academies may provide access to STEM mentors in the form of teachers or internship experiences that can provide the social and navigational capital necessary to persist along STEM pathways [9]. Both formal and informal schooling environments have the potential to provide access to positive STEM role models who can positively impact learners' STEM interest, STEM identity, and sense of belonging [8,10].

Researchers have found a positive relationship between high motivation and the pursuit of a STEM career [11], as well as declines in motivation for students at the high school level [3,12,13]. To that end, researchers have argued for the need to study the motivating factors that engage students in STEM programs as it would provide insights into how best to design interventions to increase their participation, improve the engagement of underrepresented students, and address equity issues in STEM education [13,14]. This is especially the case for Black boys, who often contend with racial stereotypes, experience feelings of not belonging in STEM, and lack motivation in school overall.

The purpose of this study was to examine the reasons that Black boys participated in a high school academy of engineering. We were also interested in identifying academy features that helped promote (or inhibit) positive STEM identities. The research questions that undergirded our study were:

1. What are the reasons that Black male students participated in a high school academy of engineering?
2. How do their reasons for participation compare to the community cultural wealth factors identified and the factors that researchers have found to influence students' STEM identities?
3. What features from the NAF engineering academy helped shape their reasons for participation and contributed to the development of a STEM identity?

In this study, we focused on the naming of an array of knowledge, skills, abilities, networks, and academy features that encouraged Black boys in a high school academy of engineering to participate. Our analyses highlight the ways in which Black boys pursue STEM and resist societal racism and other forms of oppression. We used STEM identity and Yosso's framework because they pertain more closely to students who come from ethnically and racially diverse backgrounds and are asset-based frameworks that speak to this particular population.

2. Review of Literature

2.1. *Impact of STEM-Focused Schools on Racially Minoritized Students*

Researchers have demonstrated that exposing students to integrated STEM programming as early as elementary school can help them develop competence in scientific practices and increase their interest in pursuing STEM pathways [15]. One way students can gain early exposure to integrated STEM programming is through attending STEM-focused schools. In recent years, research on the impact of STEM-focused schools on racially marginalized students has gained interest. Means et al. (2016) examined inclusive STEM high schools and found that they are positively associated with advanced high school science and math course completion (particularly in precalculus, calculus, and chemistry); informal STEM education participation; STEM career interest; and STEM postsecondary degree aspirations [16]. In their comparison of inclusive (no admission requirements) STEM-focused and non-STEM-focused high schools in two cities, Eisenhart et al. (2015) found that though the STEM-focused schools had initial success, they were unable to maintain it [17]. They concluded that the schools should be implemented with attention to addressing system issues that ethnically and racially diverse learners who come from economically disadvantaged backgrounds face. Lynch et al. (2013) found that inclusive STEM high schools can be viewed as opportunity structures: educational environments that provide access to high-quality STEM instruction as well as the social and navigational capital necessary to be successful in STEM majors and careers [18]. Research by Lynch et al. (2018) identified four foundational components necessary for STEM high schools to serve

as opportunity structures for racially minoritized students: a flexible and autonomous administrative structure; a college-preparatory STEM-focused curriculum that is made available to all students; well-trained teachers and teaching staff; and supports for racially minoritized students [19]. To summarize, by offering a combination of rigorous, high-quality STEM curricula and appropriate wrap-around supports, STEM schools can provide opportunities for equity in STEM.

2.2. The Career Academy Model

Career academies are programs that are embedded in high schools, offering college preparatory content integrated around a career theme [20,21]. They require engagement with employers and postsecondary representatives and the fusion of both academic and career-themed curricula to enhance the meaningfulness to students' career interests [21]. Findings from prior studies demonstrate that the career academy model contributes to increased student engagement and career decisions [22]. Even further, researchers have demonstrated that career academy student participation resulted in heightened student engagement, attendance, graduation rates, academic achievement, and long-term employment wages [23,24].

Hence, the career academy model has rapidly increased its presence in the United States, with roughly 8000 academies serving more than 1 million learners [25]. However, the fidelity of implementation across sites varies, and this has prompted efforts to guide the development of standards of practice by non-profit organizations, such as NAF (formerly known as the National Academy Foundation) [21]. NAF offers professional development, technical assistance, and STEM-related curricula to schools that establish career academies. Founded in 1982, NAF has implemented a national network of high school career academies in five career themes, including engineering and IT [26]. Currently, NAF has 216 engineering and IT academies serving 48,406 students from 176 high schools across the nation. The demographics of learners in the academies are 47% female and 53% male. Eighty percent of NAF academy students are ethnically and racially diverse (e.g., Black and Latinx). Sixty percent of NAF academy students qualify for free and/or reduced lunch [27].

In 2022, 99% of NAF academy seniors graduated high school, 87% of graduates were college-bound, 11% joined the workforce, and 2% joined the military [27]. The NAF model has four domains of practice. First, schools are required to focus on the academy development and structure through the implementation of smaller learning communities. Schools are required to form student cohorts, build career-themed and academic content, provide academic and career-themed teachers with common teacher planning time, provide students with career counseling and guidance, and have teachers participate in ongoing professional development. Second, teachers are required to integrate career and academic lessons around a career theme (e.g., engineering and IT) and implement project-based learning activities, establish work-based learning experiences (e.g., job shadowing, resume writing, mock interviews), and internships related to the career theme. Third, schools are required to build advisory boards representative of the community (e.g., business/industry and postsecondary representatives) to make sure that their academies are locally relevant and supported. Fourth, schools are required to implement work-based learning activities related to career awareness and exploration within the ninth (e.g., field trips) and tenth (e.g., job shadowing) grades and real-world activities (e.g., industry certifications, paid internships) in the 11th and 12th grades.

To that end, practice, exposure, and mentorship were components deemed essential in developing STEM identity with Black high school students [1], and these are all features offered in NAF academies. Hence, these three mechanisms offer a natural pathway for NAF academies to contribute to an intentional role in the STEM identity development of students, particularly with ethnically and racially diverse learners.

2.3. STEM Identity Development

In many school systems across the country, there is a lack of ethnically and racially diverse role models in STEM pathways [2]. One of the leading reasons for the lack of ethnically and racially diverse STEM students is that many do not believe their identities, backgrounds, and experiences align with the STEM profession [1,2]. Stated differently, many ethnically and racially diverse learners do not believe they have a STEM identity.

There are studies that focus on the STEM identity formation of pre-collegiate Black boys [1,2,28]. Some of the work regarding STEM identity formation in Black boys is at the undergraduate level [2,28], on pre-collegiate Black boys who are participating in advanced coursework or gifted education [28], or on Black boys in informal STEM contexts [1]. This leaves a gap in the literature that we intend to address in this study by examining what Black boys described as motivating factors related to their participation in a high school engineering academy. We also examined whether the academy fostered their STEM identities. We utilized both STEM identity development and community cultural wealth as our theoretical frameworks.

Identity is a belief that students develop about themselves through various formal (e.g., STEM academies) or informal (e.g., internships) experiences. As an example, engineering identity represents the idea that learners do indeed believe that they can perform well in engineering and that the field connects to their personal backgrounds, experiences, and identities [29]. Social identity theory is defined as an individual's self-concept, which is based on two factors: personal identity (one's perspectives on their individual skills, abilities, or attributes) and social identity (a sense of belonging within a social group or groups) [30,31]. Kim and Sinatra (2018) argued that using social identity theory to frame science identity is useful because this framing allows for understanding the impact of others (such as peers) on identity formation, and it is conducive to investigating the role of environment in the formation of science identity [32]. Social identity theory also demonstrates how ingroups and outgroups work within various contexts [30,33,34].

There are various definitions of STEM identity. Dou et al. (2019) use two terms to define STEM: STEM interest and STEM recognition [35]. Patrick and Borrego (2016) and Tonso (2006) conceptualized engineering identity as having three parts: competence, performance, and recognition [36,37]. Hazari et al. (2010) found that physics identity included four parts: (a) recognition, which is when others acknowledge that one is doing well in physics; (b) interest, which represents one's desire to do well in physics; (c) performance, which includes one's ability to do well in physics; and (d) competence, which encompasses one's understanding of physics [38]. Further, Hughes et al. (2013) categorized STEM identity into three parts: (a) interest in STEM; (b) self-concept in STEM; and (c) how role models contribute to learners' understanding of the STEM field [39]. Patrick and Borrego (2016) indicated that one's engineering identity development should be put within the context of one's social identities (e.g., ethnic/racial background, gender, SES) [36]. In this study, we define STEM identity as the degree to which a person sees him or herself as a person who does and/or participates in STEM-related fields. This self-conception is impacted by a variety of factors (e.g., interest, role models, opportunities to practice STEM). STEM identity, as defined here, is formed and developed over time and within the context of other factors, such as a person's race, socioeconomic status, environment, or family background. Therefore, we used a mix of STEM identity definitions in our analysis (See Table 1).

STEM identity development contributes to an individual's STEM career pursuits [40,41]. Much of the research on STEM identity was concerned with the development of students' identities as STEM professionals throughout their college experiences. For example, to gain an understanding of professional identity, using a qualitative approach, Pierrakos et al. (2009) examined college freshmen who persisted in their engineering major and compared them to students who switched majors [42]. They found that exposure to both engineering experiences and engineers was important to identity development. Moreover, STEM identity is an important factor in students' persistence toward STEM degrees [43,44]. Fortunately,

researchers have found that STEM identity is malleable and can be developed over time [1]. In this study, we included all of the elements defined by various researchers.

Table 1. Science, Technology, Engineering, and Mathematics (STEM) identity development constructs.

STEM Identity Development Construct	Definition	Researchers
Competence	One's understanding of STEM	[36–38]
Interest	One's desire to do well in STEM	[36,38,39]
Performance	One's ability to do well in STEM	[36–38]
Recognition	Others' recognition that one is doing well in STEM	[36–38]

2.4. STEM Identity Formation among Ethnically and Racially Diverse Learners

Henderson et al. (2021) found three components when one forms engineering identity for Black boys: (a) practicing STEM; (b) engaging with STEM role models/professionals; and (c) access to STEM mentors [1]. STEM practice helps students to develop a STEM self-concept [45]. STEM practice involves hands-on learning [45], internships [6], afterschool programs [35], and service-learning or summer programming. These opportunities allow learners to perform the concepts they are being taught and to develop their STEM competence. It also enables students to engage in low-stakes opportunities to decide whether they desire to seek out STEM as a college and/or career pathway. Henderson et al. (2021) found that positive STEM role models contribute to STEM identity development as they can relieve issues related to stereotype threat (perceived confirmations of stereotypes about groups of people) [1]. Atkins et al. (2020) found that mentorship commonly played a role in science identity formation among students from underrepresented groups [46]. Based on their research on STEM identity exploration of students and alumni in a government-funded STEM minority participation program, Fan et al. (2023) recommended access to mentors as a potential avenue in which students could explore STEM career pathways that contribute to their long-term STEM identity formation [47]. Rainey et al. (2018) indicated that science identity is one of the factors that contribute to one's STEM sense of belonging, particularly for ethnically and racially diverse students, and found that many students had challenges engaging in group work with White male students [48]. Thus, it is important to match students with role models who share their ethnic and racial backgrounds to enhance students' sense of belonging. This enables them to see role models who connect their cultural interests and will help them navigate the social and cultural ecosystems found within STEM environments.

Henderson et al. (2021) also proposed several factors that hinder engineering identity formation [1]. These factors included identity interference (suppressing one's identity in the presence of others) [1,49], lack of a sense of belonging [2,49], and culturally irrelevant methods (not using one's culture as a source of context in a subject area) in which STEM curricula are often taught [49,50]. This particular framing is useful for understanding ways that educational programs can foster STEM identity formation among ethnically and racially diverse learners because it links characteristics of STEM identity to programmatic features that can be adopted, implemented, and improved as needed.

2.5. Community Cultural Wealth

In addition to STEM identity development, we utilized Yosso's (2005) community cultural wealth (CCW) framework to understand how Black boys used their cultural assets as an aspirational mechanism to pursue engineering within the context of participating in a NAF academy of engineering [51]. In education research, Black boys are often viewed through a deficit lens, focusing primarily on what they lack. In response, Yosso (2005) developed a strength-based, anti-racist, and anti-deficit framework designed to empower

marginalized individuals [51]. Yosso's concept of CCW is a critical race theory challenge to mainstream interpretations of cultural capital, namely, Bordieu's cultural capital theory [52].

Based on cultural capital theory, the development of cultural capital requires familiarity with a society's dominant culture for one to be successful in education [52]. Yosso (2005) argued that cultural capital theory views students of color as learners who come into the classroom with cultural deficiencies [51]. CCW aims to focus on the diverse cultural capital (knowledge, skills, abilities, and contacts) possessed by marginalized groups (Yosso, 2005) [51].

Yosso (2005) identified six forms of capital, each highlighting a key tenet of the theory: aspirational, familial, linguistic, navigational, resistance, and social (Yosso, 2005) [51]. CCW is used in this study to account for the array of knowledge, skills, abilities, and contacts possessed by Black boys as they rely on these assets to inspire them to participate in a formal STEM program (a NAF STEM academy) and develop a positive STEM identity. CCW is an ideal framework for contextualizing the experiences of Black males as they learn to navigate and thrive in STEM, a collection of fields in which they have been historically underrepresented. We define each CCW tenet in Table 2 below.

Table 2. Six forms of capital in Community Cultural Wealth (CCW) theory [51].

Form of Capital	Definition
Aspirational Capital	Ability to maintain hopes and dreams for the future, even in the face of barriers.
Familial Capital	Cultural knowledge nurtured among families and extended kinship networks. This knowledge carries a sense of history, memory, and cultural intuition.
Linguistic Capital	The intellectual and social skills attained through communication experiences in more than one language or style.
Navigational Capital	Skills of maneuvering through social institutions.
Resistance Capital	Knowledge and skills acquired through oppositional behavior that challenges inequality.
Social Capital	Networks of people and community resources.

2.6. Literature Related to CCW for Black Boys in STEM

In the nearly 20 years since Yosso published her seminal work on CCW, there has been an active body of research in which CCW has been used to study pre-collegiate Black boys [53–55]. This work has focused on examining how diverse forms of cultural capital that Black boys possess can be utilized to improve their educational outcomes. In recent years, there has been a growing body of literature in which CCW has been used to better understand how Black males' cultural and intellectual assets can be used to promote their success in STEM fields [56,57].

Brooms and Davis (2017) examined how Black boys' college aspirations and expectations were informed by aspirational, familial, and social capital [54]. Their qualitative study examined the secondary and postsecondary experiences of 59 Black college students. They discovered how media, early exposure to college, family support, and motivation contributed to the college aspirations and motivation of Black students to attend college. Scholars have also used CCW as a framework in the study of K-12 Black boys' educational experiences. Howard found all six forms of capital that form CCW to be present in varying forms in his participants [55]. He noted, for example, that many of the young men interviewed in his study exhibited navigational capital as it related to gaining college access.

In recent years, researchers have started to apply CCW to study Black males in STEM subjects. Burt and Johnson (2018) studied the origins of early STEM interest among Black male graduate engineering students [56]. Applying CCW, they found that family members helped cultivate and maintain their interest; teachers affirmed and strengthened their interest; interest in math and/or science were motivating factors; and participation in STEM-based play connected learning and STEM interest for the participants. They concluded that Black males' families, teachers, and activities were key to their early interest in STEM. This

suggested that familial capital and social capital helped foster aspirational capital toward STEM for Black males. In addition, Slack et al. (2023) utilized CCW to understand the assets that Black males utilized as they pursued advanced engineering degrees [57]. They found that passion for knowledge, financial considerations, early exposure to graduate school, and the influence of social networks promoted positive aspirations to pursue advanced degrees in engineering. They concluded that Black males rely on social and navigational capital to support future endeavors. They also noted the importance of social networks in inspiring Black males to pursue advanced degrees, more so than family influence.

Tolbert Smith (2022) used CCW as a lens to characterize the diverse forms of support that Black families and extended family members provided to undergraduate Black men [58]. Tolbert Smith found that families are influential in engineering learning and development for Black males, various forms of capital can overlap, and Black males are cognizant of family expectations of academic achievement and social responsibility. Among their conclusions, they noted that fictive kin (such as peers participating in the National Society of Black Engineers) could nurture familial, navigational, and social capital. This was particularly helpful given that the programming spans K-12, college, and the professional stages of a student's career.

Researchers have studied ways that Black boys/men leverage a diverse array of cultural assets (e.g., community resources, family and social networks, navigational capital) to excel in education [53–55]. This is particularly true of Black boys/men pursuing STEM education. Educators and researchers can provide culturally responsive pedagogies and resources that foster participation in STEM fields by acknowledging and respecting the cultural assets Black males possess [53–55]. Yet, much of the literature using CCW as a framework for Black male students is focused on their experiences at the undergraduate or graduate level [56,57]. Even the recent literature using CCW for high school Black males in STEM has been retrospective, where researchers ask high school graduates to reflect back on their high school experiences [53–55]. Hence, there is limited research utilizing CCW to examine why Black boys choose to participate in formal STEM-themed programs (e.g., NAF STEM academies) and which features of the academy contribute to their interest in STEM and the development of their STEM identities. By doing this, we can understand how Black boys' cultural capital is used to shape their motivation to pursue STEM, their STEM interest, and ultimately their STEM identity.

Accordingly, in this study, we examined the reasons why high school Black male students chose to participate in an academy of engineering. We used STEM identity development as a theoretical lens to construct our interview protocol, as well as an analytical tool to examine how Black male high school students' identities, backgrounds, and experiences align with STEM and contributed to their matriculation into the academy of engineering. We also used CCW as a theoretical lens to construct our interview protocol, as well as an analytical tool to examine the extent to which Black male high school students' knowledge, skills, abilities, and networks contributed to their decisions to participate in the academy of engineering. Both the STEM identity development and CCW are strength-based, anti-racist, and anti-deficit approaches to acknowledge the cultural capital that ethnically and racially diverse students bring with them to the classroom. These frameworks are useful for examining how students' assets provide motivation for them to engage in STEM programs. Even further, in this study, we investigated the ways that academy features factored into Black male students' decision-making to participate in the academy of engineering. We believe that our study provides insights into how best to design interventions to increase the participation of Black male students in STEM education.

3. Method

3.1. Research Design

We used an embedded case study method for studying students' experiences within a distinguished NAF academy of engineering. We followed a qualitative embedded case study design to examine the motivating factors that inspired Black students to participate

in a high school academy of engineering. In terms of our unit of analysis, our embedded case study design integrates both activities associated with the academy of engineering as a structured educational environment and academy experiences from student participants. Our study was interpretivist in nature, as we sought to capture participants' experiences in the academy of engineering, how they made sense of their participation, and how the career academy elements helped promote motivation to engage [59,60]. During discussions with the participants, we were able to examine and interpret the meaning of their decisions to engage in the academy of engineering. The embedded case study approach allowed for the documentation of rich descriptive information about the motivating factors and academy features that promoted participation in a high school academy of engineering. We used pseudonyms to replace participant and school names as well as locations.

We studied a NAF academy of engineering (the case) operating within unique contexts (e.g., community and school district) at a distinguished level according to the NAF standards of practice. NAF continuously evaluates their high school academies to assess their level of implementation based on standards of practice. They rate academies on five levels of implementation using the following hierarchy from highest to lowest: distinguished, model, certified, member, and under review. NAF's educational design is based on the following elements: academy development and structure, curriculum and instruction, advisory board, and work-based learning. In our case study, we relied on interviewing participants as a data-gathering method; interviews were conducted virtually using the Zoom videoconferencing platform due to the COVID-19 pandemic.

3.2. Selection Criteria

We purposely selected Stanton Academy (pseudonym) because it was a distinguished NAF academy of engineering, 99% of their students were Black students, and 91% of them came from economically disadvantaged backgrounds. We believe Stanton Academy would be an instrumental case to uncover why Black male students participate in a high-fidelity (e.g., close adherence to standards in its implementation) NAF academy and how the academy features and motivating factors help students to form their STEM identities and provide Black boys an opportunity to showcase the assets that they bring to the classroom. Hence, the richness of the academy context and the implementation of student supports helped us to answer our research question.

3.3. The Case: Stanton Academy

Stanton Academy is located in the city of Stanton (population of approximately 124,000) with a 55% White, 37% African American/Black, 4% Latinx, and 3% Asian population. The median income was approximately \$42,000, and 19% of the community members lived below the poverty line. The city of Stanton was home to a historically black college and university.

The Stanton Academy of Engineering is a public school with a distinguished NAF academy (one of several career-themed programs) embedded within it. It is located in an urban area within the Southeastern region of the United States. Stanton Academy has approximately 969 students and 71 teachers who are majority Black. It is led by a Black woman principal. In terms of gender, 51% of students were female, and 49% were male. Concerning ethnic and racial background, 99% of students were Black, and 1% were Latinx. Ninety-one percent of students qualified for free and/or reduced lunch. The graduation rate in 2020 was 97%, with a student college-bound rate of 90%.

Many of the students at Stanton Academy take advanced placement (AP) and dual-enrollment (where students take courses for which they can earn college credit) courses. Stanton Academy also has a feeder middle school program with a pre-engineering curriculum. The academy of engineering has an advisory board that is composed of 17 community members (a variety of local STEM professionals in STEM-related firms—many who are alumni—and higher education engineering faculty). Many of the advisory board members serve as mentors to the students. The local industries that the advisory board members

represent include environmental engineering, manufacturing industrial plants, petroleum oil refineries, chemical facilities, architectural firms, engineering consulting firms, the chamber of commerce, and STEM university faculty. The academy board supports the students by providing a variety of work-based learning experiences (e.g., guest speaking, job shadowing, 120-h internships that generally take place in the summer of the students' junior year, mentoring, mock interviews, and college visits), ACT/SAT tutoring, fundraising, and scholarships for students.

3.4. Data Collection

We relied on the knowledge of the principal to provide us with a list of participants to interview for the virtual interviews. We conducted 17 virtual individual interviews with 17 Black male high school academy of engineering students. We asked 23 questions based on our interview protocol. The content of the interview protocol was related to the experiences (e.g., motivations for participation, individuals who influenced them to participate, experiences as Black males in the academy, and how the academy helped them achieve their goals) of students in the academy. Each interview lasted approximately 30 min. We virtually recorded all interviews and had them transcribed verbatim. The university's IRB (IRB# 2020B0202) approved all components of this study.

3.5. Researchers' Positionalities

It is helpful to acknowledge our own inherent biases, perspectives, and frames of reference as researchers. This likely influenced and shaped research encounters, processes, and findings. Both of us authors are faculty (two Black men). We have professional backgrounds in the fields of career and technical/workforce education and engineering education. Both of us have studied issues related to STEM identity development, the impact of student participation in high school STEM-themed career academies, and inequities in access to academically rigorous programs in schools, particularly for ethnically and racially diverse students, as well as students who come from economically disadvantaged backgrounds. Our perspectives and experiences led to our decision to select a NAF academy of engineering as well as Black male students as focal points in this study.

3.6. Data Analyses

We used constant comparison analysis to capture the motivational factors of the students and academy elements that contributed to their decisions to participate in the academy of engineering [61]. We first read the entire dataset of transcripts. After doing so, we divided the dataset into smaller, meaningful segments. We then labeled each segment with a code. Afterwards, we compared each component and collapsed those with similar codes. Last, we developed themes for each code group.

For example, in arriving at a theme, the two authors first read every transcript individually. We then individually re-read each transcript to search for patterns/codes related to the experiences and motivational factors regarding participation in the academy of engineering and elements of the academy that contributed to their decisions to enroll. We met as a research team to discuss the codes that emerged. We then went back to the transcripts to select quotes that matched the codes—those that accurately depicted students' experiences, motivational factors, STEM identities, CCW constructs, and academy components related to the participation of students in the academy. We were finally able to discuss and agree on possible phrases/statements that represent the codes, which became our themes.

We used a hybrid approach integrating both deductive (theory-driven) and inductive (data-driven) methods [62,63]. Stated differently, we utilized the tenets of CCW and STEM identity to inform the deductive process while enabling themes to emerge directly from the interviews using inductive coding. To that end, our codes emerged from the data, and then we compared each code to the community cultural wealth and STEM identity frameworks to ascertain whether they aligned (see Table 3). Further, we developed a code book with categories and subcategories to inform the themes that emerged.

Table 3. Data analysis and interpretation.

Codes	Themes	Community Cultural Wealth Tenet	Science, Technology, Engineering, and Mathematics (STEM) Identity Development	NAF Academy Element
Building and fixing devices as a child, exposure in childhood, family encouragement, family members, father, mother, parents, parents' STEM-related careers, STEM-related activities and toys	Familial Influences: I Just Grew Up Always Watching Him	Familial capital	- Competence - Interest - Performance - Role models	Not applicable
Pre-engineering middle school	Early Exposure to STEM in Middle School as Aspirational Capital	Aspirational capital	Practicing STEM	Not applicable
Career awareness/choice/decision-making/exploration/exposure, plans for selecting STEM-related degree/major in college	Aspiration to Pursue STEM as a College and/or Career Pathway	Aspirational capital	- Interest - Practicing STEM	Career awareness/exposure through curriculum and work-based learning
Career development (e.g., internships, interviews, mock interviews, resume writing, professional development), employability skills (e.g., collaboration, creativity, critical thinking, professional skills, problem-solving), STEM pathways	Trying to Move My Way Into the Engineering World	Navigational capital	Practicing STEM	- Internships - Interviews - Mock interviews - Resume writing
Black male guest speakers, Black male engineers/professionals/role models, field trips, job shadows, representation	Black Male Role Models in Engineering: It Was Great Representation	- Social capital - Resistance capital	- Exposure to STEM role models - Access to STEM mentors	- Black male guest speakers - Black male engineers/professionals/role models - Field trips - Job shadowing
STEM aptitude	STEM: It's Always Been Something I've Been Technically Good At	Not applicable	- Competence - Performance	Not applicable
Building stuff in class, hands-on learning, STEM projects, working with hands	Hands-on Learning: It Makes You More Invested	Not applicable	- Interest - Practicing STEM	- Building in class - Hands-on learning - STEM project-based learning

3.7. Trustworthiness

We employed data triangulation strategies by conducting investigator triangulation (with research team members) to establish cross-data consistency [64]. We also conducted member checks with respective participants by having the academy students review their interview transcripts for correctness of the content.

4. Results

Based on interviews with Black male academy of engineering students, we analyzed the accounts of their experiences using CCW and STEM identity development as theoretical lenses. Thus, CCW and the STEM identity development literature helped us to analyze the experiences of Black academy of engineering students as we documented the array of knowledge, skills, abilities, and networks that led them to participate in the high school engineering curriculum. In addition, we examined the academy features that motivated them to participate. These Black male students learned to navigate and thrive in the high school STEM context, even though Black males have been historically underrepresented in STEM spaces. The following subheadings represent the themes that emerged from our data analysis.

4.1. Familial Influences: I Just Grew Up Always Watching Him

One of the assets that the Black male academy of engineering students cited as a source of their motivation to participate in the program was based on them having family members (parents in particular) who encouraged them to pursue the academy and exposed them to STEM toys and activities during childhood. Their family members discussed the long-term opportunities that may exist as a result of pursuing the academy of engineering. These family members also worked in STEM fields and drew from their own professional experiences. For Rasheed, he described:

It was more my mother's decision. She pushed me towards the school. I wanted to come. It was more for her pushing me and saying, 'This is a good opportunity. This is something that you should do. This will really help you later in life'. I feel like that's why I was pushed more towards this school.

Jordan's motivation was similar to Rasheed's. He discussed the involvement of his parents, who contributed to his decision to enroll in the academy of engineering. Jordan's parents also promoted his learning development by providing him with STEM activities and spaces to explore while growing up. In addition, Jordan was able to observe his family members in STEM spaces. Given that many of the participants had developmental experiences interacting in STEM spaces, the activities and hands-on lessons they engaged in within the academy of engineering were second nature to them. Jordan articulated:

My motivation is, my dad was an engineer, and I just grew up always watching him. . .like I always grew up watching him building computers and stuff like that and fixing computers, so that just made me want to get into the program a little bit more. My dad's an electrician, and my mom is [in the] computer science [field]. When I was younger, they used to buy me little gadgets that I could build, like robot cans, little toys I could play with dealing with engineering, so that's what made me. My motivation came from me always playing—my parents always buying me Legos and building Legos, always liking to build stuff and design stuff. When I came to the program—I mean, when I enrolled in the school, I picked engineering because that's just—when I was growing up, that's always what I was around. It's also what I knew best a little bit, just learning off my dad and family members. I decided because my mother was pushing it for me 'cause I knew how to do some engineering things already, and my dad wanted me to follow his footsteps, but be better than him. My mom wanted me to also. . .she wanted me to focus on not just computer science, but also other different types of engineering, like civil engineering, mechanical engineering. She wants me to pick an engineering [field] that I would be more comfortable with.

The influence of familial capital was evident from the accounts provided by the Black male academy of engineering students who recalled the influential support of their family members in encouraging and nurturing their pursuit in the academy of engineering, as well as by observing their parents who worked in STEM fields. Hence, these participants acknowledged that their familial capital was a source of motivation to pursue the academy of engineering. The Black male academy of engineering students expressed the cultural knowledge shared with them by their family members as they remained connected to their community resources, which also strengthened their communal bonds [51,65]. Through familial resources, the students were provided with STEM spaces in childhood to cultivate their STEM interests and educational consciousness [66] to enable them to bring this knowledge and experience into the classroom [67].

4.2. Early Exposure to STEM in Middle School as Aspirational Capital

The participants also shared with us the valuable activities and programs they engaged in that helped develop their interests in STEM. These included early exposure to STEM in middle school, as well as the academy experience that provided a STEM curriculum that enhanced their learning and helped them practice STEM. The participants discussed the role that completing a pre-engineering curriculum in middle school played in their aspirations to participate in the high school academy of engineering. According to the participants, the pre-engineering middle school offered a seamless pathway to the high school engineering curriculum. The students shared with us that they developed a sense of community with peers who attended the pre-engineering middle school program. They also noted that the middle and high school teachers collaborated with each other to develop a vertically integrated curriculum. Thus, the passion that the students had for engineering began to develop in middle school, and it helped that the pre-engineering curriculum from middle to high school was seamless. Devin shared:

Well, I think the majority of us went to [Stanton Middle], and they had a pre-engineering magnet academy. As we moved over to [Stanton High], we just transferred through. It was basically a curriculum that we just went straight through. We decided to choose this academy 'cause it's down the street...so it's basically like a big brotherhood. It already had the engineering major...Since it was so close, most of our teachers knew of it, the other teachers from [Stanton Middle]. The curriculum, they [the middle and high school teachers] were able to collaborate...

Rasheed concurred:

I went to [Stanton Middle], which was a pre-engineering school. I feel like going to [Stanton Middle] just really made me think, [Stanton High] is the next step to finish my learning on engineer[ing]. That's how I found it. We took classes like robotics. It just showed us and paved the way to go to high school...Once you saw it, it was like a dead hit. I was like, 'I'm going [to] that [school]. No other choices'. The decision of attending the academy, it was a no brainer. I knew from the jump that this is where I wanted to go...I think it was just the best spot for me to go to.

4.3. Aspiration to Pursue STEM as a College and/or Career Pathway

Because of their academy experiences, the Black male academy of engineering students desired to pursue a STEM major and/or career pathway. Their career exploration experiences in the academy, as well as observing family members in STEM-related career fields, provided them with a glimpse into which type of engineering field they were most interested in pursuing. For example, Devin noted:

Yeah, I plan to go through college and major in either computer science or computer engineering. I just wanna participate as much as I can and see as much as I can before I enter the workforce after I graduate... My end goal is actually to start an engineering firm. That is what I would like to do. I see myself in five years, probably, graduating [from] a college with my bachelor's degree in civil engineering, either going to get my

masters, or just moving up in the engineering world as a whole. Overall, the experience in the academy has been really amazing just to see how many people that look like me want to do what I do, or do what I do and do it well at the highest level. Overall, this academy has been really good, and I'd recommend it [to] really anybody. Not only do we know that there are opportunities, but also see them and how our goals and futures could turn out. It's been awe-inspiring.

Jordan had a specific interest in electrical engineering. He stated, "For me, academically, after high school, I want to go to college to be a mechanical engineer." He went on to say:

After high school, I would like to attend college to focus on electrical engineering because there's a lot of... jobs out there dealing with electrical work, so I'd like to become an electrical engineer...

Therefore, the academy helped them to practice STEM, which enabled them to gain experience in different engineering fields. Many of the participants were able to articulate what type of engineering field they would like to pursue as a college major. Early STEM exposure and the camaraderie that they gained in middle school contributed to their awareness of potential career options in engineering and their decisions to pursue engineering as a career/college pathway. As Rasheed hinted, the initial exposure in middle school triggered their interest in STEM. The development of STEM interests is linked to students' decisions to pursue STEM career pathways [12]. The aspirational capital developed by these Black boys through early STEM exposure and an interest in STEM motivated them to persist through the academic challenges they faced at Stanton Academy, with hopes of pursuing engineering as a college major.

4.4. Trying to Move My Way into the Engineering World

The Black boys who participated in the academy of engineering noted several features of the academy model that helped facilitate their interest and understanding of engineering as a college and/or career pathway, as well as helped them with navigational skills. They cited various career development opportunities, such as resume writing, mock interviews, and internships. These activities helped them build employability skills and gain a greater understanding of STEM-related opportunities.

The participants also discussed how the academy experience enabled them to gain an understanding of the world of engineering in terms of the various STEM pathway opportunities and how to be competitive and pursue their interests; thus, their experiences in the academy of engineering taught them navigational skills. The academy experiences also served as sources of inspiration for pursuing STEM college and/or career pathways. They believed that their experiences prepared them for future STEM opportunities while giving them a competitive advantage compared to their peers. Jordan stated:

Professionally, this has helped me learn what I want my... profession to be. Personally, this has helped me determine what type of engineer I would like to be, between civil, mechanical, and electrical. Academically, it is teaching me things on what... I would be learning in my profession.

In addition to career exposure and technical skills, the participants talked about the employability skills (e.g., collaboration, creativity, critical thinking, professional skills, problem-solving) they gained by participating in the academy of engineering. Devin emphasized:

Really, they taught us, really, how to be engineers. Like how to think like one, how engineers should be, and how to be really professional in the engineering field, too.

Jordan shared:

I think the academy will help me in all aspects... academically, it will look good going into college with the credits of already having a head start in engineering. Personally, I

think it will better me because engineering is about not only being smart and knowing what you're doing, but you also have to have a creative mind, and it also expands your creativity. I think that's how it will better me as a person and a student.

The participants told us that the academy of engineering curriculum helped them better understand what they were learning in core academic subject areas (e.g., mathematics, science). They were able to see the connections between the content areas as well as translate what they were learning in the classroom to the real world through project-based learning.

Rasheed reflected on how determination and mindset were needed to pursue an engineering-related college/career pathway. These types of dispositions inspired him to continue learning. He stated:

The most maturing part for me is when we went to LSU one time. I saw how everybody there was so smart, and they knew their work. I had to realize and talk to myself that if I wanna be on the same level as those people, or even be further than them, I have to grow as a person, learn my work, pay attention, and be a better me. . .

Based on discussions of the participants, we learned that the academy helped the students navigate through engineering spaces as well as promoted individual agency to take advantage of opportunities. This is indeed important, as STEM spaces were not created with Black male students in mind. Thus, they were able to draw on their career development experiences in the academy of engineering as well as social and psychological supports to enhance their navigational skills and functioning in STEM spaces [68,69].

4.5. Black Male Role Models in Engineering: It Was Great Representation

The academy also gave the Black boys exposure to engineering professionals who share their cultural identities through job shadowing and guest speaking opportunities. The participants were encouraged by seeing STEM professionals who they could connect and relate to. This enhanced their interests and confidence in pursuing engineering as a viable college and/or career pathway and was a form of encouragement to continue their pursuit of a STEM pathway.

The engineering role models shared the importance of hard work and perseverance, particularly as Black boys attempting to navigate in a space that has historically been White and male. This, we believe, was an act of resistance to systemic racism within STEM spaces, and the role models were a source of social capital. To that end, Devin stated:

It was great representation. They brought in a lot of Black engineers here for us to talk to and ask them about their day-to-day. Then, if we started younger, like, if we started in lower grades, they brought us to field trips to Dow and other chemical companies and other places to see Black engineers, like, what they do. We job-shadowed them and asked them about what they like and what their life is like as an engineer, what. . . steps they had to go through. Yeah, it also just helps you reinforce what you wanna do as an engineer because seeing somebody that's like you makes you more comfortable going into the field you want to. Of course, you've got to work hard and stuff. . . probably harder than some other people. It still just makes you see that, 'Okay. He's like me. I can do this too'. Yeah, it did; it helped us to see a lot, honestly, probably 90% of the engineers we'd see were African American. Yeah, it's probably close to 99, for real, 'cause literally almost all of 'em have been African American, or of other descent other than Caucasian, which is, just for me, just cool to see. Just the fact that we can do other things that other people can do as well. Yeah, majority Black. Yeah, it's amazing to see so many Black males and Black females pursuing the engineering fields. Not even engineering, STEM fields alike.

The academy of engineering students were also exposed to Black male engineering professionals during professional meetings and college visits. Cameron explained:

We took a field trip to LSU. Then, we went to. . . some meeting and they started talking', like, what y'all wanna be. A lot of kids, a lot of students—say a lot of male African American students—they were like, they wanna be like types of engineers and stuff like that. They was

like, 'Oh, he's an engineer up on the stage right now. Him sitting down, too, and him.' They was all Black, so there were a lot of engineers. They was all going to school for engineering, and they had some engineers that were already engineers there, too.

The participants knew about common stereotypes about Black people but were able to see and hear counternarratives that defied some of the low expectations and societal expectations for Black people. Cameron went on to explain:

We went on a field trip. . . We were learning' about careers and there was this engineer who was building' robots. He allowed us to test. . . the robots. We could make it do little dances and move around, and make it pick up things. You know, that was where I learned about that type of stuff. He told me about how much income he made, and what he did during his job, and what he learned in college. . . but I don't think a lot of people expect that. Like, when they see Black people going' to school, they probably think, like, every Black person probably on the football team or the basketball team.

Rasheed agreed. He also shared the sense of community and belonging that he experienced with teachers, peers, and engineering professionals who share his identities, life experiences, and challenges. The participants spoke about how the experiences in the academy widened their network of adults who can guide and mentor them. Rasheed talked about these as a source of inspiration, as well as the camaraderie and how his peers helped to encourage each other. He saw the academy as a brotherhood. Rasheed discussed:

The best part of being at the academy. . . is that when we take those field trips. . . they show you how people that look like us can be. . . Well, it shows us people that's our skin color doing the same thing that we're doing. We're trying to get to them. That's motivation. Being a Black male, I've seen other Black men and women pave the way, and show that it's not impossible. We can get there. It's really a pushing factor to where I wanna go. I wanna be successful, and see that if other people can do it, I could also do it. Well, our teachers have brought in guests that are engineers sometimes, and have their own businesses. They teach us how they made it, and how their life went. It give[s] us an idea of how our role is gonna be in the future. I'm grateful that they brought them guests. They taught me a lot. I'm more confident to go on to be what I wanna be in life. Being surrounded by people who understand me and understand the struggle of being a Black person, I'm saying as classmates, teachers, they know how hard it is sometimes. It's easy to communicate with them 'cause you're on the same level. It's not like this teacher doesn't understand what we go through at home when we leave school campuses, more understanding, and they're more helpful in some situations. Being around other Black students, it makes you feel more understandable. Because they [are] going through the same stuff that you're going through, the same struggle. They have dreams that might be bigger than yours, or the same as yours, and just have other people to compare with, and talk to. . . have more ideas, opportunities to go to us. Yeah, we have ups and downs, but we always come back as a whole to get the job done, no matter what. It's more comfortable. Being around all my other Black brothers, I think that we can all say that it opens up a lot of doors, and being in a Black predominate school it really helps us to see. We each motivate one another to do better and succeed in life. When we all grown up, we can see each other, big house, and all that. It's really a motivator to succeed in life.

Jordan concurred with Rasheed. He was inspired by his academy of engineering teacher, who is a Black man. Jordan discussed how transparent his teacher was in opening up and sharing about his own life challenges and how he overcame them, as well as providing a platform for other STEM professionals to come into the classroom and do the same. He noted:

Actually, our teacher, he's a Black male, and he's really good with engineering, like really, really good. Being in [Stanton], majority of the people you see are Black individuals. The engineering field is like, everybody is the same color, so the teachers and the students. It's actually a benefit also 'cause sometimes, they can understand where we're coming from,

and they understand what we—how we feel about something, because not all people are perfect...but they connect with you on a different level so you could at least learn from it and hopefully gain some—to get to want to do it in the future. Yes, they do introduce you to Black males that are in the engineering field because if we all—we all know that Black men aren't on the highest part of the food chain. We have to struggle a lot. They teach you and show you and tell you about their struggles and what they had to go through to make it up to their field that they're in. At [Stanton], they do introduce you to Black males in the engineering business. I would like to use it as motivation 'cause they come from some of the same places that you come from, and now they're being successful, making money. My experience being a Black male in the engineering program is really motivation, like I'm really motivated because, you go around the other schools, there's a lot of people that's not our color in the engineering field, so us being Black in the engineering field is just a little different because you usually don't see too many people. Not too many people—they count on us and believe in us to do it, so being an engineer—being a Black male in the engineering program is really big.

The participants demonstrated resistance capital, evidenced by their discussions of the skills they learned to navigate through low societal expectations of them [51]. Having this component of CCW enabled the participants to access the existing capital and resources to maintain the motivation to persist in pursuing their STEM college and/or career goals, even when society gives the impression that it is not possible because of their various identities. Through verbal and nonverbal lessons, the Black male engineering role models taught the students to view themselves as intelligent and capable emerging STEM professionals and to resist the more common and stereotypical societal messages [70]. Thus, the role models instructed the Black boys to engage in behaviors and maintain attitudes that challenge the status quo. This is similar to the transformative resistance capital described by Villenas and Dehyle (1999) [71,72].

4.6. STEM: It's Always Been Something I've Been Technically Really Good At

The participants shared with us that they had a natural passion, interest, and high aptitude for STEM coursework. This was a source of internal talent based on STEM identity development. The Black boys enjoyed the nature of STEM coursework, as it requires problem-solving, troubleshooting, technical, and technological skills. Devin explained:

...for me, the reason why my motivation for wanting to go into engineering is because I've always wanted to do it. It's always been something I've been technically really good at. You know? Giving ideas and giving ways to solve problems that usually people can't solve. You know? I was good at math and science. For me, it's just I've always been good at it; so, why not do it? I guess I've always just liked the math and science aspects of it. I'm more of a computer person but I also like engineering, so I plan on majoring in either computer science or computer engineering, which is what I'm good at, and it's what I like.

For Cameron, he enjoyed engineering because he had an interest in troubleshooting and fixing devices; he was able to practice those skills by fixing devices for members of his family. He also had an interest in learning how to program and develop games.

Well, my motivation for enrollment in the academy, like, always seeing' people in programming and make cool games, and I always wanted to try computer science because, like, it's something' you can do, it's something' you can enjoy, something' that will get you—like you don't have to—it's hard to explain, but I'm always around the house fixing my...phone, fixing everything for my family and stuff. They're like, 'You need to be going' to school for engineering' and stuff," so it just always motivated me to get into an engineering program.

The participants discussed how they developed a STEM identity that began in childhood. Their identities were shaped both through formal (e.g., STEM academy) and informal (e.g., childhood experiences working and thriving in STEM spaces) experiences. The participants told us accounts of their high performance in STEM subject areas and how they

developed a passion for STEM while growing up working in STEM spaces. They also shared how people would acknowledge and recognize their high STEM aptitudes. Their positive STEM identities served as a source of motivation for them to pursue STEM college and/or career pathways.

4.7. Hands-On Learning: It Makes You More Invested

The participants also shared with us that they were interested in engineering because they have an affinity toward building things and enjoyed the engineering program because of the hands-on nature of the coursework that actively engaged them. They discussed various fun, exciting, and challenging project-based learning activities that enabled them to be competitive and were quite memorable to them, as well as validated their choice for engaging in the engineering academy. Jordan talked about how the academy teachers used a variety of instructional strategies that appealed to him. He also told us about a couple of projects that he thought resulted in a positive learning experience within the academy of engineering, as well as how the engineering course integrated core academic (e.g., mathematics) content within the academy's career-themed curriculum. For Jordan, he learned to use failures as lessons and thought that he retained knowledge better within the context of working on projects. He provided us with examples of some of his most memorable class projects and explained why.

Rasheed had memorable project-based, hands-on learning experiences in the academy of engineering. He told us of his interest in building things and how he envisioned engineering as a college and/or career pathway. Rasheed stated:

I joined the engineering academy because I like building stuff. Then, I saw robotics. It was very interesting to me as a freshman. I wanted to go in more depth than that and see how I can better myself, and learn. . . something I will enjoy doing later in life. I enrolled in the engineering academy because I found. . . mechanical engineering and chemical engineering. I wanted to go into college with it. I picked the best school. . . to have engineering and learn more. It gave [me] new opportunities to see light in my eyes, like civil engineer where they build bridges. I'm interested in it. They really have a good program. We do projects such as the symposium. We built a bridge to help cars cross the road, and made it more like a roundabout. . . better opportunities that'll open more doors for jobs and college. Just to maybe help me succeed in life. It really helps a lot.

Devin concurred with the other participants with regard to his affinity for engaging in hands-on, project-based learning within a competitive and challenging environment. He described how this type of learning and problem-solving opened his mind to be more innovative in his thinking. Like the other participants, Devin described memorable learning experiences with project-based learning and competing in an engineering symposium. He also articulated how the skills that he learned in the academy of engineering were preparing him for his chosen college and/or career pathway in mechanical engineering.

Based on the participants' comments, they had an engineering identity based on (a) recognition, which is the acknowledgment by others that one is performing well; (b) interest, which is the desire/curiosity to think about and understand; (c) performance, which is one's belief in one's ability to perform required tasks; and (d) competence, which is one's belief in one's ability to understand content (Hazari et al. 2010) [38]. The possession of STEM identity for these Black males is quite promising and an important finding, given that oftentimes, individuals from ethnically and racially diverse backgrounds (e.g., Black and Latinx students) continue to be underrepresented in STEM fields (Ortiz et al., 2019). Based on the literature, one of the issues related to Black male underrepresentation is that they may not perceive that their identities align with STEM fields because of the present historically dominant STEM culture, particularly given that these fields are overrepresented with White males (Ortiz et al., 2019) [2]. In many school systems across the country, there is a lack of ethnically and racially diverse role models in the teaching profession as well as students in STEM pathways (Ortiz et al., 2019) [2]. Thus, the academy provided opportunities for Black male students to nurture their STEM identities.

5. Discussion

Researchers have emphasized the critical nature of creating a pipeline of pre-collegiate Black students who are interested in pursuing STEM college majors and careers [73–75]. In this study, we responded to the call by examining the assets that Black male students possess that contribute to their motivation to pursue STEM college and career pathways, as well as how high school STEM-themed academies promote Black students' interests and motivation to engage in STEM [76,77]. The purpose of our study was to examine the reasons that Black boys participated in a high school academy of engineering. We were also interested in identifying academy features that helped promote (or inhibit) positive STEM identities.

To address our first research question, we examined the reasons that Black boys participated in a high school academy of engineering. The participants in our study articulated numerous reasons that they chose to participate in the academy of engineering. For example, family influence (a tenet of the community cultural wealth framework) was a motivating factor for students. The participants in our study shared with us that they had family members (parents in particular) who encouraged them to join the academy of engineering. Their parents also exposed them to STEM spaces, STEM toys, building structures, and other STEM activities (STEM practice: a tenet of STEM identity development) during childhood. Thus, the participants benefited from having cultural knowledge through familial resources. This cultural knowledge promoted their STEM interests (a tenet of the STEM identity development framework) and heightened their educational consciousness around STEM [66]. They were also motivated because of their early exposure to STEM in middle school (STEM practice: a tenet of STEM identity development), interactions with Black male STEM professionals (access to STEM professionals: a tenet of STEM identity development), and affinity with hands-on pedagogical approaches (a function of the NAF STEM Academy) in the STEM classroom.

5.1. Connection to the Community Cultural Wealth Framework

To address our second research question, we compared their reasons for participating to the CCW factors identified by Yosso (2005) and the factors that researchers have found to influence students' STEM identities [51]. We found that the Black boys in our study brought six forms of capital with them. These forms of capital served as sources of motivation to participate in the academy. The forms of capital that were related to Yosso's (2005) framework included the following: aspirational, familial, navigational, resistance, and social [51]. While we did not uncover linguistic capital in our data analysis, we did find an additional source of capital that was not reflected in Yosso's (2005) CCW framework: STEM identity/talent development [51].

5.2. Connection to the STEM Identity Development Framework

We found that the Black boys in our study brought with them their own natural talent that they cultivated across their lifespan based on the formation of STEM identities. Thus, the Black boys did indeed have a STEM identity that began in childhood. Based on the accounts of the participants, they described how they performed well in STEM areas both currently and growing up (performance is a tenet of STEM identity development) and that their identities, backgrounds, and experiences aligned with STEM [2,29]. To that end, the Black boys had high aptitudes (competence is a tenet of STEM identity development) in mathematics, science, and technology-related subjects. The Black boys in the academy of engineering in our study articulated that they had STEM interests (a tenet of STEM identity development), were recognized throughout their lifetime for their high STEM aptitudes (recognition and competence are tenets of STEM identity development), performed well in STEM-related activities, courses, and tasks (performance is a tenet of STEM identity development), and were profoundly impacted by Black male role models (access to mentors is a tenet of STEM identity development). These are all key elements in the development of a STEM identity [35–38,47]. Even further, their STEM identities served

as a source of motivation for them to pursue STEM college and/or career pathways. Within the context of STEM, we believe that Yosso's (2005) framework reflected the motivations and aspirations of Black boys in the high school academy of engineering but should be expanded to incorporate STEM identity/talent development as it relates to the natural interests and abilities that students bring with them that serve as assets that contribute to their motivation [51].

In addition, we found that the forms of capital are not mutually exclusive or static; instead, they inform and build on one another (Yosso, 2005) [51]. For example, the aspirational capital that the students possessed was not based solely on their early exposure to a STEM curriculum in middle school but was also formed based on other forms of capital, such as familial capital, navigational capital through their academy experiences, resistance capital in the form of the inspiration they gained from exposure to Black professional men in engineering, and because of their STEM identities. To provide another example, the navigational capital they gained was not only through their participation in career development activities but also came from hearing the Black male engineering professionals discuss how they themselves were able to navigate within the STEM field despite the low societal expectations for Black boys and men—a form of resistance and social capital.

5.3. NAF Academy Elements That Contributed to Motivation

To address our third research question, we found their identities were shaped both through formal (e.g., STEM academy) and informal (e.g., childhood experiences working and thriving in STEM spaces) experiences. To that end, we examined which features from the NAF academy model helped shape their reasons for participation and contributed to the development of a STEM identity. We found that the academy features that facilitated Black boys' motivations for participating in the academy of engineering included gaining exposure in the engineering field through career development; the building of professional, employability, and creative skills; the connections they developed among content areas that helped them perform better in core academic subjects; and the exposure that they acquired through interacting with Black men who served as role models in engineering through job shadowing, guest speakers, professional meetings, and college visits. Thus, the NAF academy model was seen as beneficial to the students and solidified their interest in pursuing STEM as a college and/or career pathway. Our findings align with the evidence that high school STEM-themed career academies are effective at engaging and promoting interest in STEM, particularly for ethnically and racially diverse students, because of the hands-on nature of the curricula and the increased interpersonal support of the small learning community [7,16].

Our findings are also promising, given that researchers have found that students' decisions to pursue STEM fields are made at the high school level [12], and students who participate in STEM high school programs are significantly more likely to have higher aspirations to earn a degree in STEM [16] and attain STEM occupations in adulthood [16,78]. Even further, we found that the academy was a positive contributor to developing a positive STEM identity and exposing them to STEM college and career pathways for Black male youth.

5.4. Recommendations for Practice

It is critical that school personnel tap into these motivating factors to engage Black boys in formal STEM programs and as a way to foster their interest in pursuing STEM-related college and career aspirations. Given that Black male role models are an important factor in helping Black boys form STEM identities [1,10] as well as fostering a sense of belonging [48], we recommend that schools integrate STEM curricula and programming for Black boys as well as provide Black male STEM role models in the form of guest speakers, job shadowing, mentorship, internships, and other work-based learning experiences. School personnel can also tap into their motivation by building early exposure to STEM in middle school, increasing their access and interactions with Black male STEM professionals, and

appealing to their interest in a hands-on curriculum that integrates problem-based learning approaches (a function of the NAF STEM Academy). Hence, the NAF academy model is an effective intervention to promote STEM interest among Black boys.

6. Conclusions

Researchers have argued for the need to study the motivating factors that engage students in STEM programs, as it would provide insights into how best to design interventions to increase their participation, improve the engagement of underrepresented students, and address equity issues in STEM education [14]. This is especially the case for Black students who often contend with racial stereotypes, experience feelings of not belonging in STEM, and lack motivation. We posit that in response to the everyday forms of racism encountered by Black male high school students, these students were able to access CCW and their own STEM identities as protective responses to the invalidating experiences they often encounter in society.

7. Limitations

The Black male academy of engineering participants in this study were purposefully selected from one high school. Thus, our sampling procedure limits the ability to generalize to Black male students in other schools and to students from other genders and ethnically and racially diverse backgrounds. However, our use of an embedded case study may allow us to make analytical generalizations based on the theoretical frameworks (CCW and STEM identity development) implemented to situate our study. An additional limitation was that we had a small number of participants, and they had similar backgrounds, experiences, and cultures. But qualitative inquiries, including case studies, typically use small samples, and in the logic of purposeful sampling, the intent is to capture and describe the central themes that cut across participants. Our intent in using this sampling approach was to uncover common themes reflective of Black male academy of engineering students. Further, we only examined STEM identity from one point in time rather than a longitudinal approach to studying STEM identity over a longer span of time.

Author Contributions: Conceptualization, E.C.F.J. and T.K.C.; methodology, E.C.F.J.; formal analysis, E.C.F.J.; writing—original draft preparation, E.C.F.J. and T.K.C.; writing—review and editing, E.C.F.J.; funding acquisition, E.C.F.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Science Foundation's (NSF) ECR and Noyce grant numbers 2151029 and 2000472.

Institutional Review Board Statement: The study was conducted in accordance with The Ohio State University, and approved by the Institutional Review Board of The Ohio State University protocol code 2020B0202 on 8/202/2020 for studies involving humans.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author due to privacy and ethical restrictions.

Conflicts of Interest: The authors declare no conflict of interest.

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