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The Inner Workings of a STEM Professional Learning Community for Middle School Black Boys at an HBCU

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Black male students are consistently reported to be underachievers and underrepresented in science, technology, engineering, and mathematics (STEM) disciplines in K-12 settings. These students often experience challenges learning STEM content because of poor student-teacher relationships and ineffective teacher praxis. STEM professional learning communities (PLCs) have practical and empirical support backed by policy and are viewed as effective practices in K-12 school settings. Considering the academic experiences of Black boys, STEM PLCs have not been conceptualized as an effective strategy for examining, teaching, and engaging them in STEM content. Using a PLC framework, this study provides insight into a Black boys' STEM PLC and how it impacted their learning of content, built their confidence, and provided career exposure.

Keyword: Black boys, STEM PLC, mentoring, STEM program

A large body of scholarship on the professional learning community's (PLCs) ability to enhance teacher and student learning has been amassed over the last two decades (Van Lare & Brazaer, 2013; Vescio, Ross, & Adams, 2008). There is widespread, empirical, interdisciplinary support for policies governing and practitioners participating in PLCs, even across STEM disciplines. STEM PLCs have been viewed as professional learning spaces to enhance student learning content through collaboration (Fulton, Doerr, & Britton, 2010; Fulton & Britton, 2011). Black boys are regularly reported as underachievers in STEM disciplines, mainly mathematics and science. Their achievement outcomes are often related to negative interactions between students and teachers and issues with their teachers' praxis (Berry, 2008; Bonner & Goings, 2019; Davis, 2014). Despite the support for STEM PLCs, they have not been conceptualized as spaces to enhance teacher professional learning and student outcomes for middle school-aged Black boys participating in out-of-school programs at universities. This article examines the scholarly literature focused on Black boys and men in STEM and STEM PLCs. It subsequently presents a conceptual framework

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to study PLCs and explains the methodology used to study STEM PLCs at an HBCU. Next, the article reports findings from an examination of a STEM PLC intended to serve middle school-aged Black boys, and finally, concludes with a discussion of the results, implications, and necessary future research.

Literature Review

This review examines the scholarly literature on Black boys and men in STEM PLCs in education and STEM education itself. These research bodies are essential to understanding how stakeholders in PLCs devoted to Black male students operate both within and outside of school learning spaces.

Black Boys and Men in STEM

Black boys and men are consistently reported as being underrepresented and underachieving in STEM disciplines in both K-12 and higher education settings. This reporting has contributed to a deficit narrative suggesting that Black boys and men are incapable of achieving and persisting in STEM disciplines. In response to this deficit narrative, educational researchers have ushered in a paradigm shift focused on successful and high achieving Black male students in STEM at the K-12 and higher education levels. The researchers leading this charge have predominantly focused on Black men at the collegiate levels in two-year and four-year institutions and graduate school at Historically Black Colleges and Universities (HBCUs) and Predominantly White Institutions (PWIs).

This body of literature provides evidence that Black male collegians have experienced success in STEM disciplines at HBCUs. Although limited, the available research about Black men in STEM majors suggests that in-person campus supports, such as participation in peer study groups and specialized programs, positive relationships with and mentoring from professors, and the positive environment at Historically Black Colleges and Universities (HBCU), contribute to their success in these disciplines (Fries-Britt, Burt, & Franklin, 2012; Gasman, Nguyen, Conrad, Lundberg, & Commodore, 2017; Kim & Hargrove, 2013; Lundy-Wagner, 2013; Palmer and Wood, 2012). Given HBCUs’ success with Black men in college, many have created and operated programs for young Black male students in middle and high schools to increase their representation, preparation, and success in STEM majors and career fields. Black boys' learning experiences in pre-collegiate STEM programs have been vastly under-researched, particularly about how teachers instruct and interact with them.

The limited research on Black male students in STEM has primarily focused on young men at varying levels of achievement in urban, suburban, and rural K-12 school settings (Berry, 2008; Davis, 2014; Thompson & Davis, 2013; Thompson & Lewis, 2005). A consistent finding in the literature about Black males at these academic levels is the problematic nature of Black male students' relationships with their teachers, the cultural disconnect with teachers and teaching styles, and teachers' inability to manage their classrooms and learning outcomes. These findings suggest that how Black male students are taught and their teachers' interactions with them, in K-12 classrooms may interfere with or negatively impact their learning of STEM content. The problems associated with Black male students’ school barriers to learning STEM content, including issues with their STEM teachers, are heightened during their middle school years (Davis, 2014;

Thompson & Davis, 2013). Some scholars have called for teachers of Black male students to pursue increased and enhanced professional development, specifically in STEM areas.

PLCs in Education

Extant literature has provided insight into the assumptions and characteristics of professional learning communities (PLCs). Scholars have argued for three assumptions that guide PLCs, namely that a) a teacher's knowledge is best situated in their lived day-to-day experiences, b) that it is best understood through critical reflection with others who share the same experiences, and c) that teachers actively engaged in PLCs will increase their professional knowledge and enhance student learning (Buysse, Sparkman, & Wesley, 2003; DuFour, 2004; Thompson, Gregg, & Niska, 2004; Vescio et al. , 2008).

PLCs operate under various designations (Vescio et al., 2008), including "the teacher community," "teachers and learning communities," "critical friends," or "communities of practice:" and the PLCs are defined by five major characteristics:

a. Shared collective values and established norms;
b. A clear and consistent focus on student learning;
c. Reflective dialogue, extensive and continuing conversations with educators about curriculum, instruction, and student learning;
d. Make teaching public; and
e. Focus on collaboration (Bolam, McMahon, Stoll, Thomas, Wallace, Greenwood, Hawkey, Ingram, Atkinson, & Smith, 2005; Buysse et al., 2003; Newmann, 1996; Thompson et al., 2004; Vescio et al., 2008)

Collectively, these characteristics define PLCs as communities constructed to promote and sustain the education of all stakeholders in the school community for the collective purpose of enhancing student learning (Bolam et al., 2005).

The ever-expanding body of research examining PLCs has provided insight into their impact on teaching practices and student learning. Most of the research has primarily consisted of self-reported positive impact, however, and includes fewer empirical studies of PLCs' effect on teaching practice and student learning (Vescio et al., 2008). However, large-scale, multi-site research has provided insight into PLCs' general characteristics (Bolam et al., 2005). Well-developed PLCs have made a positive impact on both teaching practice and student achievement. Much of the research on PLCs has focused on K-12 school settings, but very little is known about PLCs in out-of-school learning spaces.

The term PLC has been used very loosely in education without explicit assumptions, characteristics, and definitions. Schools, school systems, and state departments of education are framing stakeholders to work in terms of PLCs. However, the use of the PLCs verbiage does not guarantee or demonstrate that there are clear assumptions, characteristics, and definitions of the learning community. Most PLCs have not established a common practice using data demonstrating changed teaching practices and improved student learning. This lack of clarity threatens to diminish the apparent significance of PLCs (DuFour, 2004; Vescio et al., 2008).

PLCs in STEM Education

Interestingly, there is a breadth of published scholarship—including dissertations, journal articles (peer-reviewed and non-peer-reviewed), book chapters, books, conference papers/presentations, and web pages—on STEM PLCs, addressing many different aspects of STEM educational design, implementation, and impact (Fulton, Doerr, & Britton, 2010; Fulton & Britton, 2011). Many STEM PLC experts and practitioners have published works that share their knowledge and offer advice, descriptions of models, and lessons learned through praxis, but without formal research methodologies and findings. Most of these published works recommend STEM PLCs but caution stakeholders seeking to develop and operate them.

Fulton and associates argue that STEM PLCs must involve three or more teachers, focus on STEM content, and be sustained enterprises operating overtime. Additionally, Fulton and colleagues argue that PLCs should function to a) engage stakeholders involved in the educational process in the development of their professional practice; b) focus on learning for professionals and students; and c) engage a community with a shared vision, goals, purpose, sense of trust, and collaborative work. Current explanations of PLCs in STEM suggest that they must operate around six guiding principles: a) shared values and goals, b) collective responsibility, c) authentic assessment, d) self-directed reflection, e) stable settings, and f) strong leadership support (Fulton & Britton, 2011). Accordingly, administrative support, trust-building, and facilitating adult learning are critical elements of STEM PLCs (Fulton et al., 2010).

In addition to the aforementioned empty designations in many PLCs, there are also PLCs with STEM in the title that does not necessarily cover all of the disciplines that the acronym connotes (Fulton et al., 2010; Fulton & Britton, 2011). Most STEM PLCs occur in K-12 school settings, where many of the "STEM" PLCs focus on mathematics and, to a lesser extent, science (Fulton et al., 2010). In our review, "STEM" PLCs rarely concentrate on technology and engineering education, especially in K-12 school settings. One plausible explanation is that engineering is seldom taught as a content area in K-12 schools at all. To some extent, technology is covered with K-12 students across the US educational system, but not nearly as much as mathematics and science courses are. STEM PLCs in the United States are often actually mathematics PLCs by a different name.

Most of the research on STEM PLCs involves qualitative studies of in-service teachers across the K-12 spectrum and has primarily focused on mathematics. Fortunately, investigations of PLCs in mathematics show positive results on students' learning and achievement. Nevertheless, there is little evidence that STEM PLCs contribute to changes in teacher beliefs, STEM content knowledge, and/or STEM content pedagogical knowledge. Research also provides evidence that STEM PLCs increase teachers' deliberation about their students' thinking, reasoning, and understanding of the content (Fulton et al., 2010). Still, more research on STEM PLCs in technology and engineering is needed. This study addresses the literature gap by examining STEM PLCs with middle school STEM teachers, college professors, college student mentors, and program directors in an out-of-school program at an HBCU. This examination focuses on the inner workings of the STEM PLC, specifically the practices used to teach and engage middle school Black boys in the discipline.

Conceptual Framework

Van Lare and Brazaer (2013) have called for the use of conceptual frameworks in studying PLCs to address two central weaknesses underlying existing research on PLCs. First, most research on PLCs lacks theoretical grounding to analyze teacher learning. Second, little attention is paid to the contexts in which PLCs function and operate. The PLC conceptual framework marries sociocultural and organizational learning theories. Sociocultural learning theories are intended to illustrate possible contextual processes within PLCs, while organizational learning theories aim to explain the PLC's potential to generate school- and district-wide change.

Five primary variables influence PLCs, including isomorphism, undiscussables, governing variables, double-loop learning, and logics of appropriateness to study learning within PLCs (Van Lare & Brazaer, 2013). Institutional isomorphism explains contextual influences that come from the schools and districts in which PLCs function. Such contextual influences control the structure and substance of teacher conversations within PLCs, affecting both teachers and the mission of organizational learning. Undiscussables are unaddressed issues in the PLC that impact teaching and learning. Governing variables pertain to the rules, routines, and practices that guide the PLC. Double-loop learning indicates that PLCs explore varying theories, gaps between theories and practice, undiscussables, and alter governing variables to allow for experimentation. The logic of appropriateness centralizes the routines for how PLCs should function based on school and district-level advocacy.

These five areas impact routines, replays, rehearsals, and extensions that are a part of the PLC framework. Routines are complex enterprises in PLCs that are recurring, influenced by multiple actors, and affect decision making, individual and group actions, teaching, and student learning (Van Lare & Brazaer, 2013). Replays are specific interpretations of past events, such as a detailed retelling of classroom events (including teacher and student interactions). Rehearsals are generalizations that are recounted by teachers to represent future practice, including replaying teaching practices and predicting how students will react to new content. Replays and rehearsals represent collaborative learning, facilitate teacher communication, and manifest spaces for teachers to converse about undiscussables. Horn and Little (2010) elaborate on replays and rehearsals by indicating that lesson plans and student work become more critical in understanding problems. Extensions are interactions that incorporate teachers' examination of replays or rehearsals more closely to make meaning of the problem or situation under discussion.

This conceptual framework is dynamic; it impacts both PLC processes and outcomes and can be adjusted with empirical data. Although this framework stresses the importance of context, it is primarily conceptualized based on school and district contexts. This study expands the use of this theory by using it to understand multiple stakeholders' experiences, roles, and responsibilities in supporting middle school-aged Black boys in a STEM PLC on an HBCU campus.

Methodology

This study is a segment of a more extensive mixed-methods study on Black male students participating in out-of-school STEM programs at HBCUs around the county. The broader research sought to understand and examine the pedagogical practices, mentoring structures, and program elements that are determined to be effective in increasing middle school Black boys' interest and preparation in engineering content, concepts, coursework, majors, and careers. This article highlights one of the aforementioned HBCU campus STEM programs with a successful track record of preparing Black men to be computer engineers and computer scientists at the undergraduate and graduate levels. Over 85% of the students at the HBCU are African American, and over 30% are men.

STEM Program for Middle School Black Boys

The STEM program seeks to address Black men's underrepresentation in STEM majors and career fields by focusing on preparing younger Black boys for competency in STEM subject areas. The program collaborates with faculty in the College of STEM and College of Education to serve middle school-aged Black boys during the all-day, weeklong, summer technology classes and their equivalent Saturday classes during the academic year.

STEM programming for middle school-aged Black boys was centered on traditional and innovative STEM content and pedagogical practices, including mathematics, 3-D printing, virtual/augmented reality, drones, coding, and app development. It was delivered through hands-on, active, and experiential learning opportunities, and enhanced by character education, entrepreneurship, and physical education as elements of a whole-child approach to curriculum programming and pedagogical practices. It was also embedded within an informal setting of learning. Black male students in the program were mentored by Black male (and female) college students majoring in computer science or computer engineering, facilitated through a group mentoring structure. The liaisons also mentored college students.

The program engaged students in two instructional tracks: one for new students and one for advanced students. New students engaged in instructional experiences that helped them focus on learning the foundational skills of 3D printing, mobile app development, and engineering. Advanced students engaged in instructional experiences about robotics, drones, and virtual reality (VR).

STEM PLC Participants

The STEM professional learning community was composed of engineering and education principal investigators, certified Black male and female middle and high school teachers in STEM, college professors, and Black male (and female) college mentors. Within the PLC, STEM university faculty contributed professional expertise and content knowledge to lesson planning and instruction. At the same time, middle school liaisons—namely the middle and high school teachers—worked to ensure that content was relatable to middle school Black boys and communicated effectively through instructional practices. The mentors were either computer science or computer engineering majors who worked with Black boys in groups, attended classes, and assisted them with courses.

The program involved various pedagogical modalities, including small and whole group instruction, peer observation of instructional practices and mentor engagement, daily debriefings, one-on-one communications, and professional development, which facilitated the STEM PLCs culture of reciprocal learning as the best approach to program improvement. The PLC's primary function is to drive continuous improvement and ensure Black boys' success through STEM engagement.

Data Collection

The research team collected data from Black male students, Black male (and female) college student mentors, STEM college professor instructors, middle school liaisons, and key staff members. The team administered surveys to students, mentors, and instructors, conducted focus group interviews of students, conducted individual interviews of mentors and instructors, and performed classroom observations. In total, the research team collected 62 pre-STEM program attitude surveys from students, 55 student instructional surveys, 16 instructor and mentor instructional surveys, four individual instructor interviews, four middle school liaison individual interviews, six individual mentor interviews, seven focus group interviews (35 students), and classroom observations. This study will highlight data collected from individual and focus group interviews.

Data Analysis

The data analysis is an iterative and reflexive process that began as data were being collected rather than after data collection had ceased (Creswell & Creswell, 2017). The interview transcripts were transcribed, verbatim, through online services, and reviewed for accuracy by the research team. We individually read through the data and continuously interpreted them throughout the project. Ideas and notes were recorded to determine the meaning of the text and how it might relate to the study focus or other issues. We identified and refined essential concepts and findings as a vital part of the iterative process. Participants' names were changed in the results to protect subjects' anonymity.

Findings

The study yielded three significant findings: a) the inner workings of a STEM PLC at an HBCU, b) effective strategies for teaching Black boys STEM content, and c) the program's impact on Black boys in STEM.

The Inner Workings of a STEM PLC at an HBCU

The PLC was composed of STEM and education program directors, certified Black male and female STEM teachers, racially diverse STEM college male professors, and Black male (and female) STEM college mentors. The roles and responsibilities for directors, professors, liaisons, and mentors vary in the PLC. The directors provided higher-level oversight over the program and grant operations, and the teachers—specifically, a Black male high school science teacher—served as leaders of the PLC.

Middle school liaison. The liaisons played a major role in shaping the STEM PLC and making sure that everyone worked together. Tia discusses how middle school liaisons work with professors to provide these Black boys with the appropriate level of rigor and challenge.

> **Tia:** I would definitely say that as middle school liaisons, we are here to serve as a middle ground between the professors and the students; to make sure that the professors are creating a rigorous curriculum at a grade- and age-appropriate level for the young men. We try to make sure it is not too far above their heads where they cannot understand it, but we do not want it to be simple, either. We want it to challenge them definitely. But these are college professors, so they will—often unknowingly—give them something really hard. Still, we want them to be challenged.

Another liaison shared her perspective on their roles and responsibilities. Denise discusses how middle school liaisons help STEM professors provide the students with rigorous instruction.

> **Denise:** So, as a liaison, we have a middle school education background. Our role basically is to ensure there is a connection between the professors, being that they are generally

> teaching on the collegiate level, so they are not as in-depth with the middle school kids. We are there to bridge the gap and make sure everybody on one page ensures that the kids get what they get as far from the rigor or the information that the professors put together.

Kevin, the PLC leader, provides his perspective, elaborating on the middle school liaisons' additional role in mentoring and supervising college students.

> **Kevin:** As a middle school liaison, my primary role is to make sure that the professors teach to the kids' level and prepare them to pass middle school. It is also my responsibility to make sure that my mentors are actually mentoring and representing what I want to see reflected in my students.

Another liaison observes that his role involves sharing best practices on teaching middle school boys and creating and shaping lesson plans and building STEM program content.

> **Mark:** As a middle school liaison, I am basically here to evaluate and give feedback on best practices about how to teach middle school [Black] boys. I have a lot of input on how we teach. And, we have input on what we teach—we can create our own lesson plans in certain situations.

Mark describes how liaisons shape the program content, teaching methods, and pace of the lesson. Mark discusses how middle school liaisons create and shape lesson plans and building program STEM content.

> **Mark:** Mr. Walker, for example, can create the lesson plan for Tinkercad and things of that nature. So, it's not just giving the program to the instructor and saying, "Hey, teach this." We created pacing guides on what should come first, how long we should stay on each subject, and how far we should push the kids.

Mark further describes how professors need to make adjustments to teach middle school students and how he has seen progress with professors and liaisons over his four years of working in the program.

> **Mark:** One of the things that we notice in a program like this is that professors are used to teaching adults; many forget what it's like to teach a little boy who might wiggle or talk or play. Over the last four years, I have seen the professors' progression toward more accommodating teaching practices and that of the other middle school liaisons. As time passes, they learn how to deal with that kind of energy without deeming it something wrong or something bad, coming to recognize it as just a different age group with different characteristics.

STEM college professors. STEM professors received professional development on pedagogical practices from the liaisons over several years. Dr. Yin recalls, "Actually, there's some training; one-week training before the program starts."

> **Dr. Thai:** We do have professional development training over the years. We are being taught here as a part of the program. Some school professionals teach us professional development classes.

The liaisons also provided insight into the content of professional development.

> **Kevin:** Well, university instructors, I think they have gotten accustomed to teaching a certain way, especially teaching to adults. And so, one professional development session that we have is centered around classroom management. Another one is centered around student engagement. There is a difference in teaching at the collegiate level and teaching middle school boys, which requires different approaches.

These professional development experiences were designed to equip university faculty better to teach Black boys with diverse knowledge and learning styles.

Middle school liaisons also share their perspectives on STEM professors' roles and responsibilities. In the PLC, college professors are responsible for computer engineering content and developing the lesson plans for Black male middle school students. Kevin shares how the team receives and reviews the lessons before the summer programming begins.

> **Kevin:** The professors are required to submit a lesson plan to us, and we have a format that we have developed for them. And so that format with them submitting to us in advance, as seasoned teachers, we can kind of look and see whether it's long enough, whether some more needs to be added, whether it is challenging enough, and whether it is getting across the content that we want to get across. We do that collectively, online, where we have an open document to which everyone can contribute. Still, each professor is required to submit lesson plans, and we go over them as a team… We like to get our lesson plans before the summer starts.

Denise elaborates on the lesson planning process, explaining how the liaisons seek to ensure that the professors' lessons are rigorous and age-appropriate for the Black male students.

> **Denise:** The professors put together the lessons. We look at the lessons and view them over just to make sure that they are age-appropriate for the kids, first, with them being in middle school. Then we also ensure that there's rigor enough to where ... It is an advanced program, so you do not want to teach it on a watered-down level. You want to make the kids rise to the level of the material that they are putting together.

The professors create the lesson plans, and the middle school liaisons review them and provide feedback.

> **Mark:** The instructor has the say-so to say, "Hey, I really wanna teach this, or I really wanna teach that."And we take that, and we come back to the table as the middle school liaison. In the process, we think of the best method to teach what the instructor wants to teach. Because let us be honest, they do not have to do lesson plans. So that is the input and the planning situation that we have.

The liaisons do not tell the professors what to teach, but they provide feedback on different aspects of the lesson.

> **Kevin:** We do not tell the professors what to teach, what activities to push, and so we want it to be as rigorous as possible. These kids are very smart, and you would be amazed at what they can consume and digest and regurgitate to you much better than you ever thought about doing. And so, we kind of leave it open to the professors' interpretation as to how to get that content across, but try to stick with our objectives. So, with the professors, actually... it goes back and forth. Sometimes the professors ask us for our guidance and direction and take it, and sometimes we piggyback off of them. But it is up to the professor as to what content they are going to teach as long as they are staying with the objective.

STEM professors also received professional development on pedagogical practices because of the instructional observations by liaisons and feedback from students and mentors. Lesson observations, feedback, and self-reflection that occur throughout the program often guide the professional development offerings. The liaisons, professors, and mentors collaborate on content and pedagogy used in the program in many ways.

> **Mark:** Professor agrees, and the professor works his way through the program, learns the program, and then comes back, and we all work together to teach that program. But the most important thing about it is the collaboration. What program we use is not just determined by us; it is not just determined by them. And how we choose to teach the program, we also go back to the professors and say, "How do we want to do this?" And

> they might say, "Hey, I should teach this class from this hour to that hour, and then we switch groups, and then we'll teach another part of this class." And we take that, and we create the lesson plan and the pacing guide from there and bring it all together.

Middle school liaisons and mentors learned how to use the new technologies through training by STEM university faculty.

College student mentors. The liaisons also supervised the mentors and conducted daily debriefing sessions. They further receive professional development to help them better understand student development, teaching, and mentoring.

> **Mark:** One of the big issues that we must remember is that the mentors are not necessarily training to be teachers. More likely, they are training to be engineers. Even though they know the content, they have not been taught the content in a form that can be taught by someone else. So, part of my role involves explaining small practices that they can use to help control the kids and assure that they stay on point. In some cases, a situation arises where (liaisons) are teaching the teacher, so to speak, creating the best avenues for professional development and giving them the proper feedback.

The mentors were assigned a liaison to monitor and support student engagement.

> **Kevin:** And then, the mentor reports to the middle school liaison, such as myself. So, we try to spend a lot of time grooming our mentors to be better examples for our students because they spend the most time with our students. And so, we spend a lot of time with our mentors.

The liaisons mentor the college students in the program as a part of their tiered mentoring structure. The mentors within the STEM PLC participated in interviews to gauge skills and experiences in working with Black boys. Kevin elaborated on the quality of the mentors they selected.

> **Kevin:** This year, we have got fabulous mentors, and we chose... Learning from last year's experiences, we tried to choose our mentors a little bit more carefully this year. And these students are serious; they are computer scientists, they are computer engineers, computer technologists ... This is their field, so they are passionate about it. They spent the time before the summer came, learning the content before the students got here, we have got it down to a science now where scheduling and transitions are pretty and running smoothly.

One mentor, Chris, explains his take on the mentors' roles and responsibilities in the program.

> **Chris** (mentor): My role with them in the classroom is to stand by them and make sure they are attentive, make sure they are paying attention. And, if they need any help, I go by and help them out the best way I can, the best I can.

Mentors received constructive feedback on making authentic connections with Black boys through ongoing observations of mentor and student interactions by liaisons, and subsequent mentor training processes were modified based on engagement observations and student feedback.

> **Mark**: We watch, we observe our mentors; we watch how they discipline... We do most of the disciplining, but we try to check up on them to make sure that ... We try to involve them as teachers. That is as simple as it gets. You are trying to make sure that they are getting what they need. They know and understand some of the liabilities of being in the position that they are in, as well as some of their responsibilities in the position that they are in.

Sometimes the mentors provided feedback and suggested content to their professors.

> **Dr. Yin:** Also, the mentors that I have, I always, you know, talk to them, try to get their feedback. What can we do to improve? You know, our performance and let these students get more interested in STEM education, especially computer science. So, there is always a discussion with the mentors, and I always get some useful ideas, you know, to promote STEM education among our middle school students.

Dr. Yin shared how he relied on mentors to get feedback and improve instruction. Mark shares how mentors provide suggestions for content during debriefing sessions.

> **Mark:** So, at one of our liaison mentor debriefing sessions, you saw those, you saw how engaged the [college students] are, right? So, they brought that program and introduced it to their professor, and the professor's like, "Wow, cool!" At that point, we determine, "Hey, let's teach them how to use this program."

Observations of mentor-student engagement were ongoing and presented to mentors in group settings, daily debriefs, and individualized communication. The mentors share their perspectives of the debriefing sessions.

> **Martin**: [The debriefing sessions are] good because that lets us know and… the people over us know where we're at and what we need to change or what problems or what solutions we can come up with to make the program better. More activities or whatever we need to fix the program or attitudes or whatever. The debriefing is a good thing.

Daily debriefs exercised the full function of collaboration by convening all groups to engage in practice-based learning, discussing ways to reinforce and refine content, processes, and skills, sharing feedback from observations and monitoring, presenting challenges and successes, and sustaining dialogue about individual and/or group experiences from the activities of the day.

Effective Strategies for Teaching Black Boys STEM Content

Analysis of the interviews revealed various strategies that were thought to teach STEM content to Black boys effectively. The liaisons, instructors, and mentors found that most prominently, minimizing lectures effectively taught and engaged Black boys in STEM content.

> **Kevin:** There is a difference in teaching at the collegiate level and teaching middle school boys. You cannot just lecture the whole time. You must have breaks, and you must switch your teaching styles to keep the students engaged. And you cannot just pull content from the internet. So, helping the professors get to the level where their content is not something that the students can easily pull from the internet, but is also engaging and pushing them past their boundaries [was one of my chief responsibilities].

One of the college professors shares how he adjusted his teaching methods to move away from primarily lecturing the students.

> **Dr. Yin:** I am trying to update my method of teaching. So, I started initially by lecturing all the time for the kids I saw. It is not very efficient. Some of the kids get bored. So then, I sometimes ask the mentors to come to help me with the lectures… Some of these methods I even apply to my college-level students.

The professor also shared how he moved away from lecturing with his college students. Providing Black boys with hands-on activities and opportunities to use the various types of technology was an effective way to engage them in STEM content. A professor and liaison describe how hands-on activities and technology impact Black male students.

> **Dr. Thai:** The approach to teaching Black males is mostly based on hands-on activities and computer programming related methodology that can lead to a career in computing for

> these students. The reason to use this methodology is that generally, nationwide, I guess, to the best of my knowledge, the percentage of Black males in the computing industry is less [than desirable]. Training the students to use these methodologies of computing through hands-on technology translates to topics like app development or robotics programming or drones. All of this will help the student acquire and practice computational thinking, which they can later utilize when they go to college.

Dr. Thai explains how they help students understand the mathematics and science behind the technologies that they enjoy using.

> **Dr. Thai:** The background knowledge is basically upfront or the front-end part of these activities, whether it is robotics or CAD design or app development programming activities, whatever; they all look front-end. The back-end part of that is math and science. That is to be pushed up front and back and forth for the student to understand where math and science are integrated into the technology and prepare them to go for higher education and later, a successful career. Even though it looks like fun and plays kind of stuff at the front, the students at their age, or the time of the season, do not realize all that. As instructors, we aim to bring the principles of science and math into these activities. The way to do it is by giving an activity that involves problem-solving and critical thinking and sees if the student can apply the principles of science and math in performing the task.

They were helping students to understand how math and science are integrated into the technology to prepare them for college and career in STEM fields. For the instructional period (and program), the boys were placed in small groups with a college student mentor in a STEM discipline. Small and whole-group discussions provided opportunities for students to have a voice and was an effective way of engaging them.

> **Denise:** I say the group activities. Those are very effective, and, of course, some of the kids know each other from being in the program together for years. You introduced them to other kids as well, get them outside of their comfort zone a little by pairing them with maybe a new kid. That right there, communication pieces being ... Some social skills are being introduced there. The peer and them working together, I think that that helps them out.

Denise explains that group activities, social skills, and communication are effective components of engaging Black boys in the program. The small and whole-group discussions provided opportunities for students to have a voice. The facilitation and encouragement of dialogue served to empower students and reinforce the belief that their voice matters far too often, Black boys have been rendered invisible because their voices have not been respected in STEM classrooms. These strategies have played a significant role in how the program has impacted Black boys.

Program Impact on Black Boys in STEM

There are many perspectives on the impact of the program on Black boys. Early exposure to STEM content and technology at an early age was a benefit to the young men in the program. One of the mentors shared his perspective on the strengths of the program.

> **Moore:** The strengths of this program… I think that they're getting exposed to stuff like this very young and I feel like they're going in the right direction, cause even some of the stuff that they're doing, I'm getting exposed, too. Like I am learning as I am teaching them. Like we are learning together sometimes, and sometimes they teach me, you know what I am saying?

The program increased the students' confidence in doing STEM content and being prepared for STEM career fields. Many of the students shared their perspectives on the program's impact on their confidence.

> **Raymond:** I think it boosted my confidence because it makes me learn more about the stuff I want to learn like engineering, robotics, and that stuff.
>
> **Shawn:** It was a good impact. Honestly, what they teach gives me something to learn like when I get older, I can make anything, and I can know how to program it. Actually, it has boosted my confidence a lot because I learned this in the early age and when I grow up I can know this, and I can know it better than I could because I am learning about what I'm going to be when I grow up because making games is pretty difficult. But if you learn more about this, it will not be that difficult for me anymore. And it really boosts my confidence because I am starting to learn more than I used to about electronics and stuff. To me, it's different from school because in school there's no class that has to do with engineering or robotics and here this Verizon camp, this has to do with engineering, robotics, any type of science, basically, 3-D shapes and that stuff.

The program also impacted Black male students' career aspirations in ways that they have not yet recognized.

> **Erick:** It is good because the stuff that they teach us, they would not teach us this type of stuff in school. So, we are learning stuff that we can use in the real world. When we are older, we can use this to find a job, maybe. It is something that we can use to our advantage when we are looking for a job.
>
> **Gary:** I really do not want to be an engineer. Like to pursue a career in engineering. I might change my mind after the program because it is going well, and I am getting interested in engineering. Well, at my school I do not have... I do not take any robotics or engineering classes. But it is different because for that same reason as they teach me a lot of stuff about STEAM and stuff at my school day, we rarely even do some of that stuff.
>
> **Corey:** I would say the experience you get here is way different and more advanced than what you can get at school. I guess it is like it had a good impact because I have always thought about making games but never had the time to do it. When I came here, it showed me that there are some things that would teach you and push you forward to what you want to be when you get older. It makes me feel better because I am doing something, and it makes me think that I can really achieve being a game creator.

The students recognized that they would not be afforded the opportunities the program provided in school. The students enjoyed engaging in challenging STEM content and the fast pace of the program. They shared their perspectives on being challenged in the program.

> **Erick:** It is pretty challenging because it goes fast, and it pushes to your limits where you need to actually pay attention to what you need to do and what you are trying to do.
>
> **Shawn:** I think it is, like, challenging because I think it probably teaches us [in] a college way... since we are sixth, seventh graders, he might go step-by-step. But since we are on a college campus, he might just go a little fast. What I enjoy most is game making. Game making is more difficult. And if I learn about it, it makes me have more confidence in myself. I know I can reach my goal[s] in life.
>
> **Raymond:** I do not have classes that talk about robotics or technology, but my dad is like an engineer. He knows about technology as well. So, I learned from him. It is more different than what my dad told me because it is more difficult than what I learned from my dad. But it is very challenging. That is what I like about this program more.

A middle school liaison also shared her perspective on the level of challenge that the program provides to young Black male students. As a middle school teacher, Denise explains how “The content knowledge is more in-depth from this program than in the public school system.” Tia elaborates on the depth of the program.

> **Tia:** [The program is] almost college, if not college. Because when you walk away from it, the kids are programming robots. They learn how to program drones and give them the flight patterns. Robotics and stuff like that. So, it is well above where they are in middle school, and that is the benefit to a program like this… It is important to show our young Black men this information because they need to see these same things. Most of our young boys love to play games. Okay, well, why don't you become these programmers for your game? You can make your own. "Well, I wish they'd do this"! Okay, well, you are the one to create that. So, having them in a program like this lets them know, that could be me. So, it gives them something of possibility.

The effective strategies and program impact provide insight into how the STEM PLC impacted Black male students learning STEM content. Beyond the content, the students also built their confidence and gained career exposure.

Discussion

The study findings provide insight into a STEM PLC focused on middle school-aged Black boys in an out of school learning space—namely, at an HBCU. To better understand the inner workings of the STEM PLC, this essay used a PLC conceptual framework (Van Lare & Brazaer, 2013) to better describe the content, lessons, and practices intended to teach and engage Black boys. We also used this framework to determine effective strategies for and program impact on Black boys' engagement with STEM content. The institutional isomorphism presents the contextual factor influencing the structure and substance of teacher conversations within the STEM PLC at an HBCU. Most STEM PLCs function in schools and districts, not at universities with STEM college professors, teachers, or college students at historically Black institutions.

Given that the STEM PLC at an HBCU does not operate with the same accountability measures and assessments as schools, the professors, teachers, and mentors can function with a level of autonomy that allows them to focus on practices and student learning without external pressure. The STEM PLC functioned with the leadership of STEM teachers who were more familiar with these types of communities. The STEM PLC operates through professional development, reflection, daily debriefing sessions, classroom observations and feedback, and collaborations with professors, teachers, and college students in the program to support Black boys in learning STEM content. The rules, routines, and practices in the pre-summer professional development sessions, during summer professional development and reflection sessions, and end of day debriefing sessions were shaped by teachers, instructors, mentors, and students. The governing variables of the STEM PLC are the rules, routines, and practices that guide it.

In the community, the STEM teachers worked very closely with STEM professors and mentors to lead and provide them with professional development on pedagogy (and content) and daily debriefing sessions with mentors, conduct classroom observations of and interactions with professors and mentors, and provide feedback on instructional practices and student learning. STEM professors provided professional development on content taught to Black boys in the program. Mentors also suggested STEM technology and content. In the STEM PLC, all parties collaborated to discuss the program activities, routines, content, lesson plans, instruction, learning activities, and student learning.

The double-loop learning occurred in the STEM PLC by pursuing theories and practices about engaging Black boys in STEM content. The stakeholders in the PLC believed that Black boys learned STEM content best by having high expectations, challenging, and encouraging them, and actively engaging them in hands-on learning and technology with minimal lecturing. The professors wanted to make sure that the students understood the mathematics and science behind the technology. Engaging Black boys in small groups with the support mentors was also an effective means of teaching them STEM content. Using Black male (and female) college students was another effective strategy to intentionally provide Black boys with the same race and same race and gender STEM mentors and role models. They also altered governing variables to support and ensure that Black boys learned and engaged in STEM content.

During the STEM PLC sessions, replays and rehearsals of what happened throughout the day, with discussions of adjustments, informed future practices. In these sessions, directors, liaisons, and mentors, retell their versions of the day's events, including successes, problems, or issues that arise. Collaborative learning, communication among stakeholders (directors, liaisons, professors, and mentors), and discussion of the undiscussable occur during replays and rehearsal sessions. The extensions also provide insight into how professors used replays and rehearsals to examine their pedagogy more closely and how they teach Black boys (and by default their college students). This study illustrates how the STEM PLC impacted Black boys' learning of content, development of confidence, and career exploration. There needs to be more research on STEM PLCs focused on Black boys in university settings, especially at HBCUs. This body of research also needs to include appropriate frameworks to ground the investigations.

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References

Berry III, R. Q. (2008). Access to upper-level mathematics: The stories of successful African American middle school boys. *Journal for Research in Mathematics Education*, *39*(5), 464-488.

Bolam, R., McMahon, A., Stoll, L., Thomas, S., Wallace, M., Greenwood, A. Hawkey, K, Ingram, M., Atkinson, A. & Smith, M. (2005). Creating and sustaining professional learning communities (Research Report Number 637). London: General Teaching Council for England, Department for Education and Skills.

Bonner, F. A., & Goings, R. B. (2019). Academically gifted Black males: An intersectional focus on achievement across the P-12 spectrum. *Gifted Child Today*, *42*(3), 120-121.

Buysse, V., Sparkman, K. L., & Wesley, P. W. (2003). Communities of practice: Connecting what we know with what we do. *Exceptional Children*, *69*(3), 263-277.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage publications.

Davis, J. (2014). The mathematical experiences of Black males in a predominantly Black urban middle school and community. *International Journal of Education in Mathematics, Science and Technology*, *2*(3), 206-222.

DuFour, R. (2004). What is a "professional learning community"? *Educational Leadership*, *61*(8), 6-11.

Fries-Britt, S., Burt, B. A., & Franklin, K. (2012). Black males majoring in physics: How HBCUs are making a difference. In R. T. Palmer and J. Luke Wood (Eds.), *Black men in Black colleges: Implications for diversity, recruitment, support, and retention* (pp. 71-88). Routledge.

Fulton, K., & Britton, T. (2011). *STEM teachers in professional learning communities: From good teachers to great teaching.* National Commission on Teaching and America's Future.

Fulton, K., Doerr, H., & Britton, T. (2010). *STEM teachers in professional learning communities: A knowledge synthesis.* National Commission on Teaching and America's Future.

Gasman, M., Nguyen, T. H., Conrad, C. F., Lundberg, T., & Commodore, F. (2017). Black male success in STEM: A case study of Morehouse College. *Journal of Diversity in Higher Education*, *10*(2), 181-200. https://doi.org/10.1037/dhe0000013

Horn, I. S., & Little, J. W. (2010). Attending to problems of practice: Routines and resources for professional learning in teachers' workplace interactions. *American Educational Research Journal*, 47(1), 181-217.

Kim, E., & Hargrove, D. T. (2013). Deficient or resilient: A critical review of Black male academic success and persistence in higher education. *The Journal of Negro Education*, *82*(3), 300-311.

Lundy-Wagner, V. C. (2013). Is it really a man's world? Black men in science, technology, engineering, and mathematics at historically black colleges and universities. *The Journal of Negro Education*, *8*(2), 157-168.

Newmann, F. M. (1996). Authentic achievement: Restructuring schools for intellectual quality. Jossey-Bass.

Palmer, R. T., & Wood, J. L. (Eds.). (2012). *Black men in college: Implications for HBCUs and beyond*. Routledge.

Thompson, L.R., & Davis, J. (2013). The meaning high-achieving African-American males in an urban high school ascribe to mathematics. *The Urban Review*, *45*(4), 490-517.

Thompson, S. C., Gregg, L., & Niska, J. M. (2004). Professional learning communities, leadership, and student learning. *RMLE Online*, *28*(1), 1-15.

Thompson, L. R., & Lewis, B. F. (2005). Shooting for the stars: A case study of the mathematics achievement and career attainment of an African American male high school student. *The High School Journal*, *88*(4), 6-18.

Van Lare, M. D., & Brazer, S. D. (2013). Analyzing learning in professional learning communities: A conceptual framework. Leadership and Policy in Schools, *12*(4), 374-396.

Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. *Teaching and Teacher Education*, *24*(1), 80-91.