Journal of African American Males in Education
Fall 2020 - Vol. 11 Issue 2

Using Asset-Based Pedagogy to Facilitate STEM Learning, Engagement, and Motivation for Black Middle School Boys

* Sean T. Coleman
Bowie State University

Julius Davis
Bowie State University

There is a shortage of research examining Black male middle school students' early experiences, content and career exposure, and mentoring in STEM programs at HBCUs. Using Harper's Anti-Deficit Achievement Framework, this research examined the asset-based pedagogy used to teach middle school Black boys (n=169) using survey data from a more extensive mixed-methods study of STEM programs at HBCUs. Results show that Black boys perceived the instructors and mentors incorporated a relatively high level of engagement and pedagogical practice using transactional strategies (meaningful learning, learning community, teacher student relationship quality). The more Black boys perceived meaningful connections in their lessons, the higher teacher student relationship quality and learning community ratings. The use of the three transactional instructional strategies resulted in Black boys' perceived use of critical thinking in the STEM learning context. As a result of participating in the STEM programs at HBCUs, Black boys significantly increased in STEM-based academic efficacy, specifically in technology. Implications for teachers, teacher educators, and program mentors and instructors in STEM spaces for Black boys are discussed.

Keywords: Black boys, asset-based pedagogy, STEM program

Science, technology, engineering, and mathematics (STEM) interest, achievement, and access in K-12 and higher education settings for Black boys and men have been a primary concern for researchers, practitioners, and stakeholders (Bonner & Goings, 2019; Harper, 2010; Wright, 2011; Zilanawala, Martin, Noguera, & Mincy, 2018). Researchers reported Black males to have comparable interests and career aspirations in STEM fields as their white male counterparts(Anderson & Kim, 2006; Dickerson, Eckhoff, Steward, Chappell, & Hathcock, 2013).

* Correspondence concerning this article should be addressed to Sean T. Coleman, Department of Educational Studies and Leadership, Bowie State University, Bowie, MD 20715. Contact: scoleman@bowiestate.edu

Zilanawala and colleagues' (2018) longitudinal study of 7,039 Black male students in elementary and middle school indicated a lack of growth in mathematics based on standardized test scores. They suggest putting Black male students in more challenging mathematics classes appears to be the most promising approach to increase their mathematical proficiency on the standardized test over time.

The majority of the research on Black males in STEM has focused on their experiences at the collegiate level (Jett, 2013; Moore, 2006; Strayhorn, 2015). According to NCES (2019), the number of STEM bachelor's degrees increased overall from 2009 to 2018. However, the percentage of Black men receiving STEM bachelor's degrees flatlined, showing 6.1% in 2008 with a slight percentage decrease to 6 percent in 2018. These Black male percentages show the least growth, reverse in this case, compared to all other traditionally marginalized subgroups. As far as STEM doctorates, the NCES also reports that 3.9% of Black males represented total STEM doctorates in 2018, which increased only from 3.5% ten years prior. Reports of Black boys and men's low performance and representation in STEM have created a dominant deficit narrative about their supposed lack of ability and persistence.

Research results have highlighted the importance of early experiences, mentoring, and strength and asset-based strategies to remedy the reported lack of achievement and representation of Black males in STEM disciplines (Hrabowski, Maton, & Grief, 1998). Evidence-based interventions have emerged to address Black boys and men reported challenges in STEM disciplines (Maton, Hrabowski, & Pollard, 2011). There have been in-school and out-of-school interventions developed and implemented to provide Black boys with early experiences, STEM content and career exposure, and mentoring to STEM content. In this article, we examine the literature on STEM programs for Black boys and the literature on teachers and pedagogy used with Black male students. We describe Harper's (2010) Anti-Deficit Achievement Framework (ADAF) as the theoretical lens to study Black boys in middle school. We explain the methods used in the study as well as the results. Implications of study findings are discussed in relation to advancing Black boys in STEM using asset and strength based approaches.

Literature Review

STEM Programs for Black Boys

Researchers have provided insight into in-school and out-of-school STEM programs for Black boys (Berry, Thunder, & McClain, 2011; Davis, 2014; Ziker, Javitz, Fried, & Mitchell, 2016). Much of this research has occurred with upper elementary and middle school age Black boys in mathematics and utilized qualitative research methods. Berry and McClain (2009) reported findings of a qualitative study that examined the algebraic reasoning and problem-solving of 23 high-achieving African-American males in 5th–7th grades in a rural two-week mathematics program. They found that participants developed strong beliefs in their mathematics ability, had caring mathematics teachers, which all contributed to them developing positive mathematics identities.

In another qualitative study, thirty-two high-achieving Black boys in 5th–7th grades participated in a two-week summer program centered on algebraic reasoning and problem-solving in a rural setting (Berry et al., 2011). Berry et al. found four factors that contributed to African-American males developing positive mathematics identities: (a) the development of computational fluency by third grade; (b) extrinsic recognition for academic achievement (i.e., grades,

standardized test scores, tracking, and gifted identification); (c) relational connections between teachers, families, and out-of-school activities; and (d) engagement with the unique qualities of mathematics.

Continuing in mathematics, Davis (2014) described four Black boys in middle school experiences participating in an in-school and Saturday mathematics program designed to improve their scores on a standardized mathematics test using critical ethnography. The program focused on the mathematical content on the statewide standardized test. He reported Black male students' conceptual understanding and procedural fluency in mathematics was delimited by the mathematics program and focused on high stakes testing throughout the school year. Davis found that the Black boys felt unchallenged in mathematics, felt bored and disconnected from learning mathematics, and spent a significant amount of the school year learning previously learned mathematical topics.

Ziker et al. (2016) reported results from a two-year mixed-methods case study of computer science and engineering programs at four HBCU sites serving hundreds of middle school Black boys in the summer and Saturdays. The programs were intended to increase the students' interest in STEM, attending college, and pursuing STEM careers. The program sought to increase students' knowledge of mobile app development, 3-D modeling and printing, computer science and engineering, and robotics. Ziker and associates found that students' interest in attending a four-year institution did not change significantly as a result of participating in the program. They also found that students' knowledge of 3-D modeling and printing increased significantly, and their knowledge of engineering design, problem-solving, coding, and programming did not change significantly. Ziker and colleagues reported increased interest in technology, engineering and design classes, increased interest in technology, design, and engineering careers. In a one-week in-school STEM pull out program, Dickerson et al. (2016) found that upper elementary Black students in an urban school possessed an interest in STEM careers. They also reported that Black students wanted more STEM career education opportunities but were not as optimistic as Whites about getting a job in the field.

Fashola (2003) and Howard (2013) noted the importance of out of school learning spaces for Black males and how they offer particular advantages and fewer restrictions to this population than schools. Howard asserts that both researchers and practitioners need to examine the efficacy of out of school learning contexts to better understand how Black males thrive. This study fills a gap in the research literature by quantitatively examining middle school Black boys out of school learning in technology and engineering programs at HBCUs.

An Exploration of Teachers and Pedagogy used for Black Male Students (in STEM)

Scholarship on pre-and in-service teachers of Black male students, in general (Allen, 2015; Byran & Ford, 2014; Harper & Davis, 2012; Milner, 2007, 2013; Warren, 2013), and STEM (Murrel, 1994; Terry, 2010; 2011), in particular, and single-sex schools have provided insight into effective and ineffective pedagogical strategies. There is no surprise the vast majority of teachers of Black male students are white, middle class, female teachers that lack knowledge of them or how to meet their academic and social needs. Scholars have discussed the preparation of white pre-service teachers to teach Black male students in educator preparation programs (Milner, Pabon, Woodson, & McGee, 2013). Four Black male and female teacher educators discussed the challenges of preparing the mostly white, middle class, female teacher workforce to Black male students. Milner and associates asserted that teacher educators must help teachers develop a greater

understanding of Black male student heterogeneity to provide them with educational experiences that are more responsive to their academic and social needs. Davis, Goings, and Allen (2018) argued that mathematics teacher educators and pre-service teachers of Black male students need to focus on issues of race, racism, gender, class, power, and privilege to address the pejorative social imagery and prepare teachers to nurture Black male students' minds and brilliance.

Sheppard (2009) studied four pre-service mathematics teachers' experiences mentoring, tutoring, and exclusively working Black male students. He found that the prospective teachers avoided judgmental and condemnatory acts against Black male students but were able to unearth their hidden or unmet mathematical potential. Sheppard found that providing pre-service teachers with an opportunity to build relationships with Black male students helped inform their instructional practice. He stated that pre-service mathematics teachers' field experiences should be situated in a context that offers them autonomy to adjust lessons to integrate Black male students' experiences authentically.

There has been a call to increase Black men in the teaching profession to serve as role models for Black boys (Bryan & Milton Williams, 2017; Cooper & Jordan, 2003; Davis, Frank, & Clark, 2013; Lewis & Toldson, 2013). Black male students have also reported that Black male teachers have been instrumental in their educational experiences, including STEM disciplines (Greene, 2020; Thompson & Davis, 2013). Several researchers of Black men have described their culturally responsive practices (Brockenbrough, 2008; Lynn, 2006; Milner, 2016). Black male educators in STEM disciplines have used culturally responsive methods such as Black history and culture, curriculum, lessons, discussions, classroom management and decor, communication patterns, style of dress, and hairstyles to connect and build relationships with and teach Black male students. Researchers have reported mixed results of Black men's sense of responsibility and effectiveness with Black boys and their pedagogical practices (Brockenbrough, 2012; Brown, 2009; Brown & Butty, 1999; Rezai-Rashti & Martino, 2010). Byran and Ford (2014) argued that Black male teachers are needed to increase Black male students' representation in advanced and rigorous coursework in gifted education.

While considerable emphasis has been placed on Black male teachers, Klopfenstein (2005) reported that Black female geometry teachers are more successful with Black male students. Black female geometry teachers rated Black male students more positively than any other teachers including Black males. Klopfenstein found that the predicted probability that a Black male student will enroll in algebra II and continue in mathematics may increase by the proportion of Black female mathematics teachers. Evidence from Klopfenstein indicated that the shortage of Black teachers serving as role models in mathematics spaces is one barrier to Black male students' academic progress in the discipline.

Single-sex schools and classrooms have garnered national attention as educational environments that utilize effective strategies for Black male students. Researchers conducted fewer empirical studies on single-sex schools for Black male students, and there are mixed results of the success of these institutions (Flennaugh, 2017; Howard, 2013; Warren, 2017). For example, Urban Preparatory School in Chicago boasts that 100% of seniors gain admission to four-year higher education institutions, but that does not mean they actually go to college and are successful in those environments (see Warren, 2017 for a detailed account of the school). Fergus and Noguera (2010) 3-year study of seven single-sex schools for Black (and Latino) males found that a focus on basic skills, social/emotional engagement, rigorous curriculum, culturally responsive instruction, rites of passage programs, and community service had a positive influence on their educational experiences and outcomes.

Scholars have advanced gender-based theories (Bristol, 2015) and pedagogical perspectives (Murrell, 1994) for Black male students in and out of STEM spaces. Murrell (1994) investigated the responsive teaching practices for Black males in mathematics classrooms. His findings suggested that the social context of learning to be critical and that considerable communication, coordinated action, and common understanding are essential to engaging Black male students. Murrell stated that mathematics teachers who were responsive to Black males constructed meaningful relationships with them and their subject matter. The teachers had familiarity with Black male students' discourse routines and speech events. Black male students in Murrell's study demonstrated a preference for question-posing, requesting information, an eagerness to show off their mathematical knowledge, a fondness for providing an extended explanation, and "getting over" rather than admitting ignorance. Murrell's findings illustrate specific pedagogical approaches that resonate with high levels of effort and engagement with Black male adolescents.

Terry (2011) expanded research and practice related to Black male students in mathematics by using counterstories as a pedagogical approach in mathematics education. He introduced the concept of mathematical counterstories as a pedagogical strategy "for developing productive curricular and instructional interventions in urban mathematics classrooms" (p. 25). His use of mathematical counterstories focused on Black males. Terry (2011) contends that mathematical counterstories provide mathematics educators with an opportunity to address missed opportunities to reorient Black males to the usefulness of mathematics. Mathematical counterstories can be used to recount the racialized, sexualized, classed, and mathematical experiences of Black students. Terry encourages mathematics educators to "look for mathematics" in interesting and engaging spaces and mathematize situations significant to Black males. In many regards, mathematical counterstories are a form of culturally responsive pedagogy for Black male students.

Culturally responsive pedagogical practices have also been reported to be effective with Black boys (Flennaugh, 2017; Howard, 2001; Nasir, 2012). This pedagogical practice has been examined with a diverse cadre of teachers including Black men (Lynn, 2006; Milner, 2016), but has mainly focused on white teachers (Ladson-Billings, 2009). Warren (2013) examined the student-teacher interactions of four White female teachers and a group of their Black male students to understand better the utility of empathy in culturally responsive classrooms. He found empathy helped the White female teachers develop trusting student-teacher relationships with Black male students, ensure Black male students meet their high academic expectations and use teachers' instructional flexibility and risk-taking to support Black male students' learning. Warren maintained that empathy is an essential useful element of culturally responsive practices.

There are many different names (e.g., culturally responsive pedagogy) for asset and strength-based pedagogical perspectives used on Black male students. Research suggests that key interactions between teachers and students maximize cognition and learning (Gillies, 2011; Shadiow, 2010; Rugutt & Chemosit, 2009). Thus, transactional strategies focus on the strategically meaningful interaction facilitated by instructors to students and between students. These strategies depart from traditional teacher-focused approaches to pedagogy. Additionally, in a traditional learning environment, the instructor strictly defines the context and climate without considering students' backgrounds, cultures, abilities, and emerging competencies. Conversely, transactional strategies share the focus with the student(s), adopting a contextualist promoted environment. Here, the instructor facilitates a bi-directional relationship of genuine interactions to facilitate learning in a useful and meaningful way. These bi-directional transactions lead to dual development in both the teacher and the students (Miller, 2005).

A. Wade Boykin and associates (Boykin and Noguero, 2011) introduce four foundational components of transactional strategies that are mutually inclusive, yet, include distinctly separate characteristics: meaningful learning contributes to affective, cognitive, and ability outcomes by building on students' past experiences and prior knowledge and making connections to significant events in their lives. Further, outside events are made relevant to the learning context and students' cognition and learning (Stipek, 2004; Griffen and Coleman, 2019). Learning community facilitates collaborative intellectual exchanges and ensures the active involvement of students in the learning process (Coleman, Bruce, White, Boykin, & Tyler, K, 2017). Culture positively builds on the cultural, community assets, and practices that students bring to the class (Boykin, Lilja, & Tyler 2004; Coleman, 2013; Lee, 2010). Teacher student relationship quality (TSRQ) provides a socially supportive learning environment that is still academically demanding and rewards excellence, effort, and improvement (Jackson, Coleman, & Lee, 2018).

The transactional strategy components of meaningful learning, learning community, cultural resources, teacher student relationship quality, and with critical thinking show up to be effective independently; however, any combination of these components may lead to deep learning, motivation, and engagement. As a precursor to implementing various transactional strategies, a teacher benefits from being equipped with students' assets such as preferences for learning contexts, developing skill sets and learning inclinations, in and out of school activities, and traditional-functional-environmental cultural backgrounds. Mixed methods studies using transactional strategies in out of school STEM programs designed for middle school Black boys are absent. This study fills a significant void by conducting this research from an asset, integrity, or strength-based perspective that counter deficits views of Black male students.

Anti-Deficit Achievement Framework

This study uses Harper's (2010) ADAF to examine Black male middle school students' experiences in the out-of-school STEM programs at HBCUs. Theories from psychology, sociology, and education ground Harper's (2010) ADAF include a) cultural capital and social capital, b) stereotype threat, c) attribution, d) campus ecology, e) self-efficacy, f) critical race, g) college student retention, and h) possible selves theories. This framework has been primarily used to study Black male collegians (Goings, 2016) and students of color (Harper, 2010). This research adds new knowledge by using this framework to study Black middle school students in STEM disciplines.

There are broad categories of the ADAF: pre-college socialization and readiness, college achievement, and post-college persistence in STEM. In the pre-college socialization and readiness category, Harper (2010) stresses the importance of family factors, K-12 school forces, and out-of-school college prep experiences. The college achievement category includes course interactions, out-of-class engagement, experiential/external opportunities, persistence, peers, and faculty as critical components. Post-college persistence in STEM centers graduate school, STEM, and research careers as important factors. In each of the broad categories, Harper raises critical questions to invert deficit perspectives of Black male students to focus on their assets and strengths rather than their failures. Goings (2016) characterizes Harper's framework as a processing framework for Black males in STEM. For this study, we focus on Harper's pre-college socialization and readiness.

Methodology

This quantitative study investigates the association between the instructional use of transactional practices and students' learning, engagement, and motivation with STEM content for Black middle school males. Additionally, this study explores the salient facilitative affective STEM-based academic efficacy and motivation that may lead to future sustainable opportunities in STEM fields. That is, this study examined the influence of transactional learning environments that rely on instructors' implementation of pedagogy infused meaningful learning, teacher-student relationship quality, and supportive learning community. The sample for this study included 169 middle school, grades 6-8, Black boys enrolled across four STEM summer programs located at four Historically Black Colleges and Universities (HBCU). The programs are required to include a minimum of 50% of the students from low-income backgrounds as denoted by the FARMS program.

Instruments

Student Survey of Instructional and Learning Practices. The Student Survey of Instructional and Learning Practices was adapted from Capstone Institute at Howard University. The survey is designed to elicit responses of elementary and secondary students (grades 3-12) to statements relating to their teacher's instructional practices, their perceptions of classroom climate, and personal attitudes/dispositions toward instruction. The instrument comprises 36 items incorporating five categories: Meaningful Learning, Learning Community, Cultural Resources, Teacher-Student Relationships, and Critical Thinking. The survey items are of identical format and provide a statement, such as "My teacher encourages us to do our best in class at all times," followed by a 5-point rating scale, based on the frequency of the practice or observed behavior. The five categories/response options are as follows: (1) Not at all, (2) Rarely, (3) Sometimes, (4) Often, and (5) All the time. The survey is produced to accommodate several reading levels (primary, intermediate, and secondary) and takes approximately 15 minutes to complete. Category means are determined and compared to the survey's "median split" quality or frequency of occurrence.

Students' Attitudes Toward STEM Survey. The Students Attitudes Towards STEM Survey examines levels of students' self-efficacy, self-perception, and interest in engineering courses, majors, and careers. The survey contains 38 items that include both open-ended and close-ended response options. The open-ended items include items such as "What after-school or weekend activities do you participate in that involve science, technology, engineering or mathematics?" and "What would be the most fun job you could have?" The close-ended items for self-efficacy and self-perception use a five-point Likert scale that includes (1) Strongly Disagree, (2) Disagree, (3)Neither Agree or Disagree, (4) Agree, and (5) Strongly Agree. An example of a close-ended self-efficacy item is "I am good at problem-solving." An example of a self-perception item is "I can see how math is important in my life." Close-ended items that measure interest in STEM courses, majors, and careers use the following five-point Likert scale: (1) Not Interested, (2) Little Interest, (3) Some Interest, (4) Moderate Interest, and (5) Very Interested. A sample interest item is "Please rate your interest in taking classes in the following subjects in the future: Technology." The Students Attitudes Towards STEM Survey has yielded an alpha reliability coefficient of .84 for the close-ended items.

Procedures

This study represents a segment of a more extensive study that included lesson observations and individual and focus group interviews with students, mentors, and instructors, as well as included teacher survey of instructional practices. The current study segment incorporated a correlational research design with a pretest-posttest component. Students attended the STEM program Monday-Friday for two weeks on the respective university campuses. At each site, program staff administered the Students Attitudes Towards STEM Survey to students as a pretest on the first day of the STEM program, and staff administered the posttest within the last two days of the program at respective sites. Students received hardcopy surveys at one site to complete, and the data was recorded in a database for further use. Preliminary analyses showed no descriptive or inferential outcome differences between online and hardcopy administration of the instrument. Students were allotted as much time needed to complete the survey with an average completion time of 10 minutes for each pretest and posttest administration.

Independent researchers administered students' completion of the Student Survey of Instructional and Learning Practices. Survey administrators guided students to complete the survey through an online platform. Students completed the survey individually using a desktop computer and were instructed to not share responses. Students completed the survey independently; however, they were invited to request reading and understanding support if desired to complete any part of the survey. Administrators allotted unlimited time to complete the survey; however, the average completion time was 15 minutes. Students' responses were recorded in the online survey platform and managed through this mechanism until data processing and analyses.

Results

Reliabilities

Cronbach's internal alpha reliability analyses were performed on the Student Survey of Instructional and Learning Practices to determine the internal consistency of the perceived transactional pedagogical constructs—Meaningful Learning, Learning Community, Teacher Student Relationship Quality, and Critical Thinking. The Meaningful learning construct obtained an internal reliability coefficient of .76. Learning community rendered an internal reliability coefficient of .63. The TSRQ subscale obtained an internal alpha reliability coefficient of .76. (See Table 1).

Table 1

Mean, SD, and Alpha Coefficient for Transactional Strategies Implementation

	Meaningful Learning	Teacher Student Relationship	Learning Community	Critical Thinking
Mean	3.57	4.14	3.26	3.92
SD	0.76	0.53	0.68	0.77
α	0.76	0.76	0.63	0.83

Note: Students mean perception of instructors' implementation of asset-based instruction

Descriptives

Descriptive statistics were obtained for each variable subscale (Meaningful Learning, Learning Community, Teacher Student Relationship Quality, and Critical Thinking) to determine the level of perceived pedagogical practice for students in the STEM learning contexts, as determined by the survey scale's midpoint. The survey scale midpoint was 2.50. The means ranged from 3.26 to 4.14, with the Learning Community yielding the lowest mean and TSRQ revealed as the highest mean. The results show that, on average, the students perceived transactional strategies used more than the scale median split, suggesting that instructors and mentors incorporated a relatively high level of transactional engagement and pedagogical practice (See Table 1).

Correlations

Correlations were performed among subscales to examine the extent of the relationship between the transactional approaches. Table 2 shows that several significant relationships were obtained. A positive correlation emerged for meaningful learning and TSRQ ($r=.60$, $p<.01$). This finding suggested that the higher students rated their perceived presence of meaningful lesson connections, the higher was their rating of teacher student relationship quality. Additionally, meaningful learning positively correlated with the learning community ($r=.51$, $p<.01$). This finding indicated that the higher students rated their perceived learning connections, the greater observed learning community indicators. TSRQ and the learning community obtained a positive correlation ($r=.39$, $p<.01$). This result suggested that the higher the teacher-student relationship, the higher the observed learning community contexts. Critical Thinking content factors yielded significant positive relationships between meaningful learning ($r=.72$, $p<.01$), TSRQ ($r=.71$, $p<.01$), and learning community ($r=.53$, $p<.01$). These results suggest that the more teachers and mentors used critical thinking factors, the increased the use of transactional pedagogical practices (meaningful learning, TSRQ, and learning community) (See Table 2).

Table 2

Correlations between Asset-Based Strategies

	Critical Thinking	Making Connections	TSRQ
Making Connections	0.723		
TSRQ	0.708	0.595	
Learning Community	0.528	0.514	0.393

Note: Students' perception of teacher implementation

Multiple Regression

A multiple linear regression analysis was conducted to explore the influence of meaningful learning, TSRQ, and the learning community on critical thinking content focus factors. A significant regression model obtained (R^2=.66, F(3,165)=107.54, p> .01), with the three pedagogical factors combined, predicting 66% of the variance for the use of critical thinking in instruction. It was found that meaningful learning (B = .40, p>.01), TSRQ (B = .59, p>.01), and learning community (B = .18, p>.01) each significantly influence the use of critical thinking in the learning environment. This finding shows that using the three transactional instructional strategies yields to students' perceived use of critical thinking in the STEM learning context. Separately, while accounting for each of the transactional strategies, each factor significantly influences the use of critical thinking in STEM (See Table 3).

Table 3

Regression- Transactional Strategies Influence on Critical Thinking Related to STEM

	B	SE B	Beta	t	p
Making Connections	0.40	0.06	0.40	6.52	0.00
Teacher Student Relationship	0.59	0.08	0.41	7.18	0.00
Learning Community	0.18	0.06	0.16	3.07	0.00

R^2 = .66, p.> .01

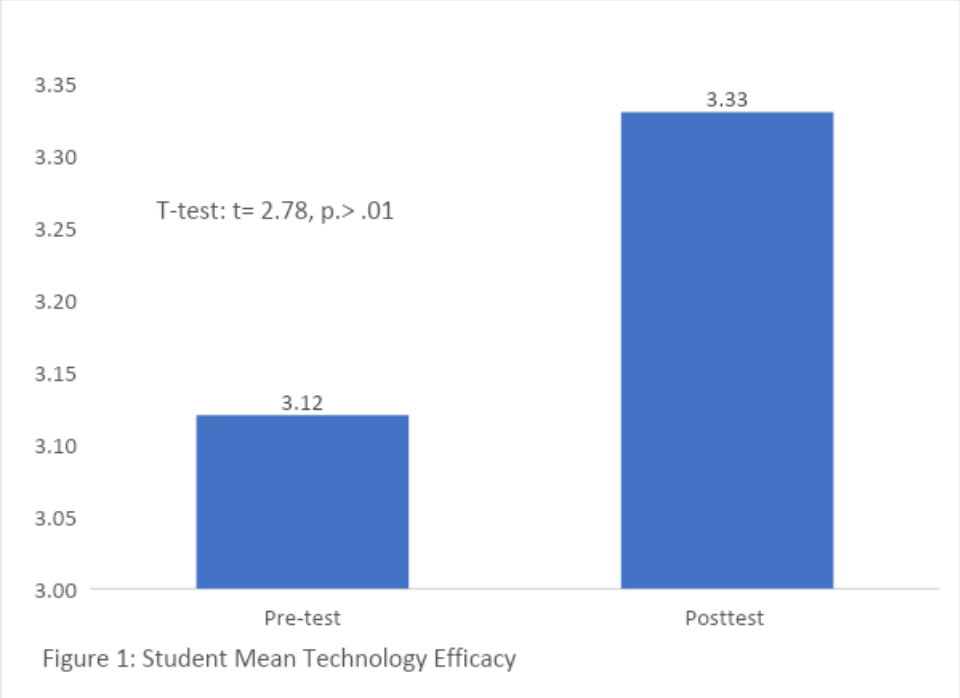
Dependent Variable: Critical Thinking

STEM Instrument

T-test. A paired (correlated) t-test was executed to analyze the pretest and posttest difference between students' academic efficacy in STEM, specifically technology, "before" and "after" the STEM program learning sessions. A significant difference emerged between the two test cycles $t(1) = 2.78$, $p > .01$. The means and standard deviations were 3.12 and .63 for the pretest, and 3.33 and .66 for the posttest. These findings disclosed that students yielded a significant increase in STEM-based academic efficacy, specifically in technology. Cohen's effect size value ($d = 0.32$) suggests a moderately substantive practical significance difference (See Figure 1).

Figure 1

Student Mean Technology Efficacy



Discussion

Reports of Black boys and men's lack of achievement and representation in STEM have created deficit narratives about their ability and persistence. Harper's (2010) ADAF provides the lens to examine Black male middle school students' pre-college socialization and readiness in computer science and engineering programs at HBCUs held in the summer and on Saturdays during the school year. Black families played a significant role in Black boys participating in the computer science and engineering programs at HBCUs. The Black male middle school students' participation in the computer science and engineering program contributed to their technology identity and readiness for technology interests. These study findings align with Ziker and associate Black boys' results in computer science and engineering STEM programs at HBCUs. The research

results from this study also align with existing findings that pre-college STEM programs positively shape Black male students' mathematics identity, competency, and interests (Berry & McClain, 2009; Berry et al., 2011; Dickerson et al., 2016). These findings also expand extant research by providing insight into how a computer science and engineering program at HBCUs shaped Black middle school students' technology identity, efficacy, and interests.

Most of the available research on transactional strategies have focused on Black students in school contexts. This study examines the use of transactional instructional practices to support Black male middle school students' learning, engagement, and motivation in STEM learning contexts, which adds to the research knowledge about the effectiveness of these strategies in out of school spaces (Fashola, 2003; Howard, 2013). Educators, researchers, and policymakers have sought solutions to provide Black boys with better access and sustainable STEM education settings that afford these students the opportunity to seek future academic endeavors and careers in STEM. Existing research and scholarship has sought to prepare teachers to be culturally responsive (Lynn, 2006), utilize single-sex schools and classes (Fergus & Noguera, 2010; Flennaugh, 2017; Howard, 2013; Warren, 2017), male-centered theories and practices (Bristol, 2015; Murrell, 2014) to the academic and social needs of Black boys in STEM.

The present study addresses an aspect of this issue by demonstrating the salient facilitative affective STEM-based academic efficacy and motivation that may lead to future sustainable opportunities in technology and engineering fields. Dickerson and colleagues' (2016) findings caution that Black male students were not optimistic about being equitable for career opportunities. This study examined the influence of transactional learning environments that relied heavily on Black male instructors' and mentors' implementation of pedagogy infused meaningful learning, teacher student relationship quality, and supportive learning community. The Black men experiences, teaching, and mentoring in the computer science and engineering programs expand the existing research literature to think about the effectiveness of their pedagogy and practices in out of school STEM programs (Brockenbrough, 2012; Brown, 2009, 2012; Brown & Butty, 1999; Davis et al., 2013). As a proxy to academic achievement, this study used critical thinking as a criterion variable and the transactional strategies as predictor variables. Further, students' technology efficacy and perceived STEM skill development were measured for increase or significant gains.

Most of the research on Black male students in STEM programs have used descriptive and qualitative research methodologies (Berry & McClain, 2009; Berry et al., 2011; Davis, 2014; Ziker et al., 2016). Descriptive and inferential statistics were used to examine the relationships between asset-based instruction and students' STEM endorsement. The students' survey responses indicated that instructors and mentors across the camp sights incorporated a relatively high level of interaction or transactional learning approaches--each factor above the scale median split. Correlational analyses indicate positive inter-correlation between each transactional teaching strategy, suggesting the more one strategy is used, the more another strategy is used and vice versa. These transactional strategies tend to exist mutually inclusively, metaphorically, 3-dimensionally connected like a spherical Venn diagram. For instance, it makes sense that students view the making of a personal connection relates to building a meaningful connection with the teacher or learning climate. Relatedly, students reported, on average, a high mean for teacher student relationship quality compared to the other transactional instructional approaches. This finding may suggest that meaningful learning and learning communities may create additional pathways to student perception in the building and sustaining quality teacher and student relationships.

The study expands results from Boykin and associates (Boykin et al., 2004; Coleman, 2013; Coleman et al., 2017) about the use of transactional strategies for middle school Black boys in pre-college STEM programs at HBCUs. As students perceive enhanced levels of transactional teaching strategies, these strategies directly impact students' reporting of lessons involving critical thinking markers. The multiple linear regression analysis revealed that using transactional teaching strategies impacts the use of critical thinking in lessons. The use of critical thinking, as a result of incorporating transactional pedagogical practices, may provide links to essential processes necessary to enhance STEM learning, efficacy, access, and academic achievement. Students' significant pretest-posttest gain may be attributed to the use of transactional pedagogical strategies, and these strategies direct predictive influence on STEM-based critical thinking. Further, a descriptive observation may be asserted concerning the likely influence of transactional strategies and their impact on the use of critical thinking on students' perceived learning and confidence in the STEM overall and particularly in technology.

This study's results support the need to increase more opportunities for Black boys to engage in STEM-based learning. Through Terry's (2011) study of Black male students, he argued that mathematical counterstories are a viable approach to increase Black male students' engagement in mathematics that are appropriate for other STEM disciplines. Further, this study may inform regular school settings and teacher education programs of effective ways to enhance STEM education from African American boys, closing gaps related to an African American presence in STEM fields (Zilanawala et al., 2018). Research and scholarship from Sheppard (2009) and Milner and colleagues (2013) provide guidance on how to prepare diverse teachers to meet the STEM and social needs of Black boys by providing opportunities outside of school settings to help them develop meaningful relationships with them, provide quality instruction, and examine issues of race, racism, gender and other forms of oppression.

Although this portion of the study does not highlight qualitative aspects, anecdotal perspective provides additional texture to the results. To that end, lesson observations revealed that program mentors created a safe space for the students to learn, embrace their respective home culture endorsements, and demonstrate high expectations with support. Mentors and some instructors engaged the students as individuals with integrity, learning the students' various preferences and using these endorsements to motivate, engage, and teach the students in the most high-level STEM curriculum. Interestingly, much of the reviewed literature indicates that STEM programs often did not report mentoring components or salience of mentors' impact on Black male students' experiences in the programs (Berry & McClain, 2009; Berry et al., 2011; Davis, 2014; Ziker et al., 2016). But further, in this study, students expressed that the STEM program learning environment sustained high goals and a rigorous curriculum in many cases. In a rigorous learning climate, students expressed that the STEM program mentors and instructors embraced the students more in a meaningful way compared to students' "regular school teacher." These may be the types of lessons that can be taken back to the schooling institution to facilitate gap closing outcomes in achievement and interest in STEM education. In turn, Black males are likely to benefit in school and beyond Prek-12, and our society may benefit from having more Black men in STEM fields.

Limitations and Future Directions

This study's results show insight into the facilitative effects of asset-based instructional practices and these strategies' impact on critical thinking and STEM academic efficacy. There are,

however, a few limitations worth mentioning. First, the present study used critical thinking as a proxy for academic achievement. This approach does not land directly on academic achievement outcomes as measured in school settings. Second, triangulating the instructors' perception of their inclusion of asset-based teaching strategies may provide additional insight to what extent students' and teachers' perceptions about instruction are in alignment. Third, this study is limited in highlighting instructor or teacher training that supports the capacity to use asset-based strategies. These limitations beg questions regarding the process of building teacher capacity (Coleman et al., 2017) but also replicability. These issues prove important to address and should be pursued in the future. Future studies that seek to examine pathways to enhanced Black male academic access and opportunity in STEM should continue by exploring the effects on academic achievement as measured by schools. Additionally, it may benefit the field to examine the lasting effects of asset-based instruction on motivation and academic efficacy in STEM. Future studies should also look to replicate successful teacher capacity models; thus, examine the process of teacher training and new teacher induction.

Acknowledgement

The research was supported by the National Science Foundation under Grant No. 1743335. The opinions, findings, and conclusions or recommendations expressed are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

References

Allen, Q. (2015). Race, culture and agency: Examining the ideologies and practices of US teachers of Black male students. *Teaching and Teacher Education*, *47*, 71-81.

Anderson, E., & Kim, D. (2006). *Increasing the success of minority students in science and technology.* Washington, DC: American Council on Education

Berry, R. Q., III, & McClain, O. L. (2009). Voices, power, and multiple identities: African-American boys and mathematics success. *New England Mathematics Journal*, *41*, 17–26.

Berry, R. Q., III, Thunder, K., & McClain, O. L. (2011). Counter narratives: Examining the mathematics and racial identities of Black boys who are successful with school mathematics. *Journal of African- American Males in Education*, *2*(1), 10–23.

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. https://doi.org/10.1177/1076217519846524

Boykin, A. W. Lilja, A. J., & Tyler, K. M. (2004). The influence of communal vs. individual learning context on the academic performance in social studies of grade 4-5 African Americans. *Learning Environment Research, 7,* 227-244.

Boykin, A. W., & Noguera, P. (2011). *Creating the opportunity to learn: Moving from research to practice to close the achievement gap.* Alexandria, VA: ASCD.

Brockenbrough, E. (2012). 'You ain't my daddy!': Black male teachers and the politics of surrogate fatherhood. *International Journal of Inclusive Education*, *16*(4), 357-372.

Brockenbrough, E.A., 2008. *Black men teaching: The identities and pedagogies of Black male teachers*.Unpublished Dissertation, University of Pennsylvania.

Brown, A. L. (2009). "Brothers gonna work it out:" Understanding the pedagogic performance of African American male teachers working with African American male students. *The Urban Review*, *41*(5), 416-435.

Brown, J. W., & Butty, J. A. M. (1999). Factors that influence African American male teachers' educational and career aspirations: Implications for school district recruitment and retention efforts. *Journal of Negro Education*, 280-292.

Bristol, T. J. (2015). Teaching boys: Towards a theory of gender-relevant pedagogy. *Gender and Education*, *27*(1), 53-68.

Bryan, N., & Ford, D. Y. (2014). Recruiting and retaining Black male teachers in gifted education. *Gifted Child Today*, *37*(3), 156-161.

Bryan, N., & Milton Williams, T. (2017). We need more than just male bodies in classrooms: Recruiting and retaining culturally relevant Black male teachers in early childhood education. *Journal of Early Childhood Teacher Education*, *38*(3), 209-222.

Coleman, S.T. (2013). Transforming communalism from a cultural dimension to a learning context for African American learners. *African American Learners*, *2*(2), 1-14.

Coleman, S. T., Bruce, A. W., White, L. J., Boykin, A. W., & Tyler, K. (2017). Communal and individual learning contexts as they relate to mathematics achievement under simulated classroom conditions. *Journal of Black Psychology*, *43*(6), 543-564.

Jordan, W. J., & Cooper, R. (2003). High school reform and Black male students: Limits and possibilities of policy and practice. *Urban Education*, *38*(2), 196-216.

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.

Davis, J., Goings, R., & Allen, K. (2019). Developing pre-service mathematics teachers to meet the needs of Black male students in teacher education programs. In G.M., Prime (Ed.). *Centering race in the STEM education of African American K-12 learners*. Peter Lang Publishing.

Davis, J., Jones Frank, T. and Clark, L.M., 2013. The case of a Black male mathematics teacher teaching in a unique urban context: Implications for recruiting Black male mathematics teachers. In C. Lewis and I. Toldson (Eds.), *Black Male Teachers: Diversifying the United States' Teacher Workforce* (pp. 77-92). Emerald Group Publishing Limited.

Dickerson, D. L., Eckhoff, A., Stewart, C. O., Chappell, S., & Hathcock, S. (2014). The examination of a pullout STEM program for urban upper elementary students. *Research in Science Education*, *44*(3), 483-506.

Fashola, O. S. (2003). Developing the talents of African American male students during the nonschool hours. *Urban Education*, *38*(4), 398-430.

Gillies, R. (2011). Promoting thinking, problem-solving and reasoning during small group discussions. Teachers and Teaching, v17,1, 73-89, 17p.

Goings, R. B. (2016). (Re) defining the narrative: High-achieving nontraditional Black male undergraduates at a historically Black college and university. *Adult Education Quarterly*, *66*(3), 237-253.

Green, D. (2020). *A phenomenological examination of Black male high school graduates placed at risk academically* [Unpublished doctoral dissertation]. Bowie State University.

Griffin, A., & Coleman, S.T. (2019). The effects of psychological verve as a learning context

and meaningful learning on motivation and engagement for African American fourth and fifth grade students. Paper presentation at AERA Annual Meeting. Toronto, Canada.

Fergus, E., & Noguera, P. (2010). *Theories of change among single-sex schools for Black and Latino boys: An intervention in search of theory.* New York: New York University, Metropolitan Center for Urban Education.

Flennaugh, T. (2017). " Life skills": A single-sex classroom intervention for Black Boys transitioning from middle school to high school. *Journal of Urban Learning, Teaching, and Research*, *13*, 53-62.

Harper, S. R. (2010). An anti-deficit achievement framework for research on students of color in STEM. *New Directions for Institutional Research*, 2010(148), 63-74.

Harper, S. R., & Davis III, C. H. (2012). They (don't) care about education: A counternarrative on Black male students' responses to inequitable schooling. *Educational Foundations*, *26*, 103-120.

Howard, T. C. (2013). How does it feel to be a problem? Black male students, schools, and learning in enhancing the knowledge base to disrupt deficit frameworks. *Review of Research in Education*, 37(1), 54-86.

Howard, T. C. (2001). Telling their side of the story: African-American students' perceptions of culturally relevant teaching. *The Urban Review*, *33*(2), 131-149.

Hrabowski III, F. A., Maton, K. I., & Greif, G. L. (1998). *Beating the odds: Raising academically successful African American males*. Oxford University Press.

Jackson, M., Coleman, S.T., and Lee, J. (2018). Integrity matters: A look at the importance of optimizing transactions between teachers and their students. Paper presentation at AERA Annual Meeting, New York, New York.

Jett, C. C. (2013). HBCUs propel African American male mathematics majors. *Journal of African American Studies*, *17*(2), 189-205.

Klopfenstein, K. (2005). Beyond test scores: The impact of Black teacher role models on rigorous math taking. *Contemporary Economic Policy*, 23(3), 416-428.

Ladson-Billings, G. (2009). *The dreamkeepers: Successful teachers of African American children*. John Wiley & Sons.

Lee, C. (2010). Every shut eye ain't sleep: Modeling the scientific from the everyday as cultural process. In C. Milbrath & C. Lightfoot (Ed.), *Art and human development* (pp. 39-166). New York: Psychology Press.

Lewis, C. W., & Toldson, A. (2013). *Black male teachers: Diversifying the United*

States' teacher workforce. Emerald Group Publishing.

Lynn, M. (2006). Education for the community: Exploring the culturally relevant practices of Black male teachers. *Teachers College Record*, *108*(12), 2497.

Maton, K. I., Hrabowski, F. A., & Pollard, S. A. (2011). African American males in the meyerhoff scholars program: Outcomes and processes. In H.T. Frierson & W.F. Tate, IV (Eds.), *Beyond stock stories and folktales: African Americans' paths to STEM fields*. Emerald Group Publishing.

Miller, P. (2005). Commentary on: Scaffolding: Constructing and deconstructing development. *New Ideas in Psychology*, *23*(3), 207-211.

Milner IV, H. R. (2016). A Black male teacher's culturally responsive practices. *The Journal of Negro Education*, *85*(4), 417-432.

Milner IV, H. R. (2007). African American males in urban schools: No excuses—teach and empower. *Theory Into Practice*, *46*(3), 239-246.

Milner, H. R., Pabon, A., Woodson, A., & McGee, E. (2013). Teacher education and Black male students in the United States. *Multidisciplinary Journal of Educational Research*, *3*(3), 235-265.

Moore, J. L. (2006). A qualitative investigation of African American males' career trajectory in engineering: Implications for teachers, school counselors, and parents. *Teachers College Record*, *108*(2), 246.

Murrell, P. C. (1994). In search of responsive teaching for African American males: An investigation of students' experiences of middle school mathematics curriculum. *The Journal of Negro Education*, *63*(4), 556-569.

Nasir, N. S. (2012). *Racialized identities: Race and achievement among African American youth.* Stanford, CA: Stanford University Press

National Center for Educational Statistics (2019). Digest of Education Statistics. Retrieved June 15, 2020, from https://nces.ed.gov/programs/digest/d19/tables/dt19_318.45.asp

Rezai-Rashti, G. M., & Martino, W. J. (2010). Black male teachers as role models: Resisting the homogenizing impulse of gender and racial affiliation. *American Educational Research Journal*, 47(1), 37-64.

Rugutt, J., Chemosit, C. (2009). What motivates students to learn? Contribution of student-to-student relations, student-faculty interaction and critical thinking skills. Educational Research Quarterly, v32, 3, 16-28.

Shadiow, K. (2010). Classroom interactions: Constructing a room with a view.

Classroom Interactions: Constructing a Room with a View. *College Teaching*, 58(2), 58-61.

Sheppard, P. A. (2009). Prospective teachers' experiences teaching mathematics to African American males. *Education*, 130(2), 226-231.

Stipek, D. (2004). Teaching practices in kindergarten and first grade: Different strokes for different folks. Teaching Practices in Kindergarten and First Grade: Different Strokes for Different Folks. Early Childhood Research Quarterly, v19 n4 p548-568.

Strayhorn, T. L. (2015). Factors influencing Black males' preparation for college and success in STEM majors: A mixed methods study. *Western Journal of Black Studies*, *39*(1), 45-63.

Terry, C. L. (2010). Prisons, pipelines, and the president: Developing critical math literacy through participatory action research. *Journal of African American Males in Education*, 1(2), 73-104.

Terry, C. L. (2011). Mathematical counterstory and African American male students: Urban mathematics education from a critical race theory perspective. *Journal of Urban Mathematics Education*, *4*(1), 23-49.

Thompson, L., & 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.

Warren, C. A. (2017). Urban preparation: Young Black men moving from Chicago's south side to success in higher education. Harvard Education Press.

Warren, C. A. (2013). The utility of empathy for White female teachers' culturally responsive interactions with Black male students. *Interdisciplinary Journal of Teaching and Learning*, *3*(3), 175-200.

Wright, B. L. (2011). K-16 and beyond: African American male student engagement in STEM disciplines. *Journal of African American Males in Education*, *2*(1), 5-9.

Ziker, C., Javitz, H., Fried, R. & Mitchell, N. (2016). *Verizon innovative learning minority male program case study brief*. SRI Education

Zilanawala, A., Martin, M., Noguera, P. A., & Mincy, R. B. (2018). Math achievement trajectories among black male students in the elementary-and middle-school years. *Educational Studies*, 54(2), 143-164.

