Confronting Color-Blind STEM Talent Development: Toward a Contextual Model for Black Student STEM Identity

Kristina Henry Collins

Abstract
What is Black student’s science, technology, engineering, and mathematics (STEM) identity? The author addresses this question through a synthesis of the literature that includes studies that explore Black student identity. Background information regarding STEM achievement and persistence followed by empirical studies that explore STEM attitudes among Black students at various educational levels are examined to determine a definition for STEM identity. The findings revealed a void in the research that emphasizes Black students’ academic strengths and positive role of cultural values as approaches to learning. Two models, Whiting’s Black Male Scholar Identity and Ford’s Female Achievement Model for Excellence (F2AME), are highlighted as particularly promising models to inform Black students’ STEM identity. The author introduces key factors of Black student STEM identity as a framework and calls for action to redress the racial and gender inequalities in current STEM talent development that contribute to underrepresentation throughout STEM pipeline.

Keywords
African American, STEM, identification, talent development, motivation, underrepresentation, critical race theory, cultural influences, achievement

Many strategies are used by institutional and educational entities to answer the call for increased training of science, technology, engineering, and mathematics (STEM)
professionals. Specifically, it only takes an Internet search to reveal the many programs, grants, and scholarships designed to decrease underrepresentation in STEM (National Science Foundation, 2014; Smithsonian Institute, 2014; U.S. Department of Education, 2013). However, scholars and practitioners continue to engage in the same conversation and ask the same questions that have been asked for many decades: How do we recruit and retain underrepresented minority students and women in STEM?

Over the course of my life span as a STEM student, professional, and educator, and as a mother of a STEM student, it has appeared that the cart is often put before the horse. All too often, there is a focus on training students in STEM without understanding how these students see themselves and their interests valued in the STEM community. Informed by my own research (Collins, 2013, 2015, 2017; Collins & Fields-Smith, under review; Collins, Price, Hanson, & Neaves, 2017), a synthesis of the existing literature and state of the STEM pipeline, and my STEM experiences over a 30-year period, I assert that educators cannot continue to initiate STEM programs without understanding student STEM identity; for students of color, this includes cultural context and racial identity. Therefore, I also assert that understanding the critical aspects of Black student STEM identity (BSSI) presented can inform appropriate STEM talent development that has significant impacts on STEM achievement and persistence for other underrepresented students.

Acknowledging the STEM talent and achievement gaps reported by race and gender (National Science Board [NSB], 2016), I provide a review of the literature to understand critical aspects of racial identity, motivation, and STEM issues among Black students that are used to explain these gaps. I conducted a synthesis of the applications of identity theories and conceptual frameworks relevant to the identity and STEM skill development of Black students to determine which theories/frameworks might best serve as a culturally responsive foundation to build upon for research regarding the intersection of Black students’ racial identity and their STEM identity. Based on key factors that emerged from a synthesis of the research, I offer a contextual framework for BSSI that has promise to guide future STEM research and intervention.

At the Surface of the STEM Problem: Recruitment and Persistence

STEM career fields are high-growth industries in the United States. According to the Bureau of Labor Statistics, computer and mathematical occupations accounted for 3.5 million jobs in 2010—with a projected growth of 778,000 new jobs by 2020; architectural and engineering occupations are expected to add 252,800 new jobs by 2020, and health care practitioners and technicians are expected to experience more growth than any other occupational group, adding 2 million new jobs by 2020 as the third fastest growing occupation group (Lockhart & Wolf, 2012). In addition, Robinson (2010) concluded there would not be enough professionals, especially minorities, to answer the call for this anticipated growth with non-Hispanic, White males making up the
majority of individuals identified as scientists or engineers in the United States. Almost 25 years ago, in 1993, working women earned 43% of all college degrees but disproportionately represented only 23% of the overall science and engineering field workforce; 20 years later, in 2013, working women earned half of all college degrees, but accounted for only 29% of those working directly in engineering and science fields (National Science Board [NSB], 2016). Ironically, in what some have considered to be a post-racial era (Lum, 2009), researchers have attributed this to complex factors in the science and engineering discipline that include gender discrimination, racial disparity in grant funding and opportunities, and racial inequity in scholarly manuscript reviewing (Ceci & Williams, 2011).

Also, in 2013, the National Science Foundation reported that Black males represented only 6% of males with degrees in science and engineering whereas women represented only 7% of all STEM-degree recipients (National Science Foundation [NSF], 2013). Although 84% of 413 STEM department chairs from leading research universities boasted concerns of recruiting and retaining underrepresented undergraduate populations in 2010, only about 33% of those acknowledged that they had a diversity plan for STEM talent development (Hughes, 2012). The need to increase minority representation in STEM continues to be a major concern for researchers, educators, employers, and government agencies (Agrawal, Stevenson, & Gloster, 2016; National Science Foundation, 2014; Wladis, Hachey, & Conway, 2015).

Getting to the Root of the STEM Problem: Identity and Interest

Contemporary motivation theories suggest that students’ academic and career choices, effort, and persistence are influenced by various psychological factors including their identity, interests, value perceptions, competency beliefs, and achievement goals (Boaler & Dweck, 2016). Moreover, students’ identities, interests, and the usefulness of a task for attaining their goals are key influences regarding the extent to which students assign value to a particular academic task or discipline. More important, students’ values and expectations are influenced by their previous experiences, cultural values, and social experiences. Expectancy-value theory (Eccles et al., 1983) suggests that students are motivated toward academic tasks and disciplines at which they expect they can succeed and also perceive as valuable. Steenbergen-Hu and Olszewski-Kubilius (2017) asserted that the likelihood of earning STEM degrees may not be fully attributable to high achievement or abilities, but more significantly influenced by race and personal interest in STEM; this assertion was based on a study of 244 previous talent-search participants that also supplemented their regular high-school curriculum with math and science enrichment. Surveying these participants 4 to 6 years after high school, the researchers examined the probability of earning STEM college degrees using a binary logic regression analysis. They found two factors strongly associated with the outcome of earning STEM college degrees: race and interest. Students who identified as Asian or White were more likely to earn STEM college degrees, as were
students who had higher personal interest in STEM. Similarly, student participation in talent search and other enrichment programs has been found to contribute to a STEM-scholar identity and intensify interests in STEM for gifted and highly talented Black students (Collins, 2017).

More specific to the development of a STEM-scholar identity, key terms such as STEM potential, STEM talent, STEM skill, STEM innovators, STEM professionals, and so forth have been used to describe attributes and/or psychological and individual factors related to interests, value perceptions, competency beliefs, and achievement goals. The NSB (2003) acknowledged that the United States has become increasingly dependent on importing STEM talent. They referred to those who have exhibited STEM potential and those with developed STEM talent as future STEM innovators. They defined STEM innovators as those individuals who have developed the expertise to become leading STEM professionals, and perhaps the creators of significant breakthroughs or advances in scientific and technological understanding. However, according to Subotnik, Kolar, Olszewski-Kubilius, and Cross (2010), “insufficient research exists to inform educators, researchers, and policy makers about how they contribute to the development of STEM talent” (p. 5). They further indicated that the long-term economic, intellectual, and scientific benefits of STEM-degree completion, career selection, creativity, and contribution from a culturally diverse population is clearly understood, but no effective long-term solutions are in place to address the lack of contributions from culturally diverse populations. Olszewski-Kubilius, Subotnik, and Worrell (2017), however, did note that evidence has shown that mathematical and reasoning ability are predictors of STEM achievement.

In accordance with the above terminology and frames of reference, the author contends that STEM identity is the ways in which one views himself or herself based on a belief in his or her ability to utilize STEM skills and/or STEM talents to become a STEM professional or STEM innovator. STEM talents are common characteristics associated with any of the specific STEM disciplines such as, but not limited to, scientific literacy, technological literacy, logical thinking, mathematical skill set, and general or domain-specific cognitive ability. Therefore, the development of students’ STEM identity is the result of reciprocal interactions among various psychological/individual factors, cultural factors, and the STEM context/environment (see Figure 1).

For example, I have personally studied and worked in the fields of computer science, engineering, and mathematics. I possess a general interest and competency in STEM as it relates to my skill set, identifying with STEM disciplines collectively, not one or the other as separate identities. At the core of my STEM identity, there exist experiences grounded in the cultural value of my STEM skill set along with issues surrounding race and gender at different stages and in different environments that have significantly influenced the development of that identity. Given that a student’s cultural milieu and interactions with the academic STEM environment may differ based on an individual’s race or ethnicity, it is important to examine student
STEM identity and talent development through a lens that incorporates race and ethnicity.

### Identity and Motivation to Persist: Theories and Frameworks

There are numerous factors that contribute to the formation of our identity. Scholars have been seeking to understand how this development occurs, especially how an individual comes to value one’s self or feel valued by others (Henfield, 2012). Sellers, Smith, Shelton, Rowley, and Chavous (1998) proposed four dimensions of Black racial identity to include salience, centrality, regard, and ideology that emphasized unique historical background and cultural perspective. An introduction of their Multidimensional Model of Racial Identity (MMRI) included an examination of the hierarchy of identities focused on the significance and nature of race as a status in defining one’s self and constructing identity. Race was situated within the context of other identities such as gender and occupational identity to provide a rubric by which to describe its meaning along a developmental trajectory. Sellers et al.’s work, along with other developmental and attitudinal models, provides a comprehensive understanding of the centralistic nature of racial identity for Black students. Tinto’s (1993) student integration model suggests that personal background characteristics and institutional context are predictors of academic success, affecting ability to persist. Pascarella and Terenzini (2005) as well as Pascarella et al. (2016) studied and reported the impact of race on educational outcomes. Baber (2012) suggested that concepts of racial identity evolve in response to events. This literature reveals that our past is influenced by experiences that are situated within circumstances, environments, cultural values and beliefs, and personal interactions. Once we begin to attach to these
<table>
<thead>
<tr>
<th>Theory/framework used</th>
<th>Author(s) of the study</th>
<th>Central topic/research question(s)</th>
<th>Relevance to Black student identity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement Motivation Theory</td>
<td>Buckert, Meyer, and Schmalt (1979)</td>
<td>Effects of difficulty and diagnosticity of choice of tasks on students in relation to achievement, motivation, and perceived ability</td>
<td>Provides insight into perception of ability and low-resultant achievement motivation</td>
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<tr>
<td>Achievement Motivation Theory</td>
<td>Capa, Audiffren, and Ragot (2008)</td>
<td>Evaluation of the Humphreys and Revelle’s model of effort; exploration of the affecting factors central to improvement of “human-machine interface,” high levels of student engagement, and control of engagement in a cognitive task</td>
<td>Possible explanation for Imposter Syndrome and/or self-doubt exhibited in Black students</td>
</tr>
<tr>
<td>Black Male Scholar Identity Model</td>
<td>Whiting (2006a, 2006b, 2009, 2016)</td>
<td>Characterized traits of Black male scholars</td>
<td>Model can be used to combat the negative effects of the defense mechanism adapted by Black student against institutionalized racism</td>
</tr>
<tr>
<td>CRT</td>
<td>Hebert and Beardsley (2001)</td>
<td>A critical case study used to understand achievement and creativity in gifted Black students living in rural poverty</td>
<td>Recognition and identification of specific needs and issues of Black students among various settings.</td>
</tr>
<tr>
<td>Ford’s FAME</td>
<td>Ford (2013)</td>
<td>Addresses unique racial and gender traits and needs of Black females in their identity development</td>
<td>Recognition and identification of specific needs and issues of Black females separate from racial connection to Black males or the gender connection to other racial groups of females</td>
</tr>
<tr>
<td>Imposter Syndrome/ Achievement Motivation Theory</td>
<td>Pishva (2010)</td>
<td>Historical review of Imposter Syndrome among graduate students</td>
<td>Origin of Imposter Syndrome as a framework to discuss achievement motivation in Black students</td>
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Table 1. (continued)

<table>
<thead>
<tr>
<th>Theory/framework used</th>
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<tbody>
<tr>
<td>Imposter Syndrome/ Social Behavior</td>
<td>McGregor, Gee, and Posey (2008)</td>
<td>The relation between the imposter phenomenon and depression in college students</td>
<td>Negative thought patterns as a trait of Imposter Syndrome similar to symptoms of mild depression disorder and their role in Black self-image, sense of belonging, and discipline perception</td>
</tr>
<tr>
<td>Nigrescence Theory (Cross, 1995)</td>
<td>Tatum (1992)</td>
<td>Use of Black Identity Development as an application tool in the classroom to discuss emotional topics such as racism and sexism</td>
<td>Examination of Black Identity Development at different educational stages of development</td>
</tr>
<tr>
<td>Nigrescence Theory (Cross &amp; Vandiver, 2001)</td>
<td>Grantham and Ford (2003)</td>
<td>Discussion of self-concept and achievement with a focus on how racial identity development affects the achievement of gifted African American students</td>
<td>Provide an enhanced and relevant discussion of the eight Black identities nested within three clusters for Black Identity Development</td>
</tr>
<tr>
<td>Self-Psychological Theory</td>
<td>Langford and Clance (1993)</td>
<td>Review of research findings regarding dynamics, personality, and family patterns, and their implications for treatment</td>
<td>Informs a cultural perspective of implications for treatment based on a review of research findings regarding dynamics, personality, and family patterns of students’ early experiences</td>
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Note. CBRI = Color-Blind Racial Ideology; CRT = Critical Race Theory; FAME = Female Achievement Model of Excellence.

influences, they begin to shape how we see ourselves and our place in the world (Hauge, 2007; Morrison, 2013). Table 1 offers an overview of studies that have been used to specifically explore Black students’ identity and motivation categorized by major, racial identity theories and frameworks. It provides a snapshot of accepted interpretation and inferences of identity and motivation from researchers and scholars who built their work on these major theories and frameworks.

Although a number of competing theories of Black racial and ethnic identity exist, the theories referenced for a basis of study generally describe the attitudes and beliefs that African Americans hold about themselves as “racialized” beings in the context of a racist society (Coleman, Chapman, & Wang, 2012). Most of the research surrounding Black students’ identity is conceptualized around the marginalization of Black identity or comparing it with the dominant race. Few research
studies highlight the strengths of the cultural practices that positively contribute to Black student identity. Each of the following theories and frameworks uniquely informs our understanding of identity and talent development in STEM for Black students.

**Color-Blind Racial Ideology (CBRI)**

In contrast to racial regard, CBRI was introduced in the late 1960s and early 1970s in the context of the civil rights movement and anti-racist movements to expose attitudes and beliefs that we live in a post-race era that transcends race and minimizes institutional racism under the premise that race does not matter today (Coleman et al., 2012). More specifically, “colorblindness is a common response to racism” (Bostick, 2016, p. 1). It emulates dominance orientation of Whiteness on everyone; translated, its encouragement to look beyond race in the spirit of fairness and sameness reinforces a mindset that “everyone is like me” (Howard, 2016). That sameness is standardized by White culture. It associates color with negative characteristics and invalidates one’s racial identity—a fundamental aspect of our being that is intimately tied to culture, heritage, and lived experiences. Lived experiences for a marginalized race of people include accounts of coping with oppression that is at the heart of race. This color-blind perspective perpetuates a myth of meritocracy that claims individuals are ultimately responsible for their own successes without considering the many factors and experiences associated with inequalities of racial background, social class, and White privilege that affects the likelihood of success (Henfield, 2012).

A color-blind perspective of STEM identity and talent development minimizes the role that racial inequalities play in the racial disparities that exist in STEM. Explained within Bonilla-Silva’s (2013) four frames of color-blind racism, CBRI negatively affects Black students’ STEM identity by way of (a) cultural racism—when Black students are not aware and/or experience a devalued sense of cultural strengths, contributions, and perspective in STEM fields; (b) abstract liberalism—emphasis on individual choice not to pursue STEM is a result of not willing to work hard enough rather than interest; (c) naturalization—naturally self-selecting not to persist in STEM studies in favor of more culturally appropriate careers; and (d) minimization—the mindset that systemic discrimination practices to influence race-based STEM identities are not rampant. Furthermore, institutional practice of valuing “soft skills” that are commonly influenced by the dominant culture disadvantages racial minorities in STEM talent development opportunities and career persistence.

**Critical Race Theory (CRT)**

CRT, introduced in the 1970s, is a contrasting opposite to CBRI. It reflects a qualitative research approach that positions race at its core and considers racism to be a problematic part of American society and educational institutions. CRT provides opportunities to discuss the complexities of identity development. It emphasizes the
importance of racial identity as a social construct. Considering race as a social construct, CRT scholars seek to unveil hidden racism within these social, institutional, and political settings (Ladson-Billings & Tate, 1995; Wallace & Brand, 2012). Specifically in education, CRT “seek[s] to identify, analyze, and transform those structural and cultural aspects of education that maintain subordinate and dominant racial positions in and out of the classroom” (Smith-Maddox & Solórzano, 2002, p. 68). Educational and social experiences guide or bound Black students’ exploration of themselves in terms of race, which also shapes their attitudes, behaviors, and identity formation. For example, Hebert and Beardsley (2001) utilized CRT to conduct a case study/ethnography of a gifted Black male living in rural poverty that also included intervention. They sought to examine relationships that guide or bound behaviors, attitudes, and aspirations of a gifted Black child in an impoverished, rural environment. The research, spanning over a 3-year period, served to inform educators about effective processes to identify and address educational needs of gifted Black children in rural poverty. Relevant to BSSI and talent development, research utilizing CRT validates the need for a culturally responsive framework to identify STEM potential and STEM talent to address the educational and talent development needs of students.

**Nigrescence Theory**

The most widely researched theory and reference to Black racial identity development is that of Cross’s (1978, 1995; Cross & Vandiver, 2001) *Nigrescence Theory, or Black Identity Development* stages (pre-encounter, immersion/emersion, internalization, and internalization commitment). This theory posits eight Black identity types within three major stages—pre-encounter, immersion/emersion, and internalization (Ford & Whiting, 2010; Grantham & Ford, 2003):

- **Pre-encounter stage** (identity types: assimilation, miseducation/stereotype, and racial self-hatred). In this stage, the student seeks assimilation into White culture, distancing himself from other Blacks and maintaining that racial indoctrination is irrelevant in his or her life.
- **Immersion/emersion stage** (identity types: anti-White and intense African American involvement). At this stage, everything of value is relevant to being or becoming Black and taking on racism.
- **Internalization stage** (identity types: nationalist, biculturalism, and multiculturalist). During this stage, students’ personal understanding and valuing of “Blackness” emerges into a sense of commitment and action based on the concerns and beliefs of Blacks as a group. What is important to understand with this developmental model is that the stages do not (nor the identity types within them) occur linearly. Categorizing the first two stages of the Nigrescence Theory as weak racial identities, Grantham and Ford (2003) introduced racial identity development as a useful construct to implement counseling initiatives designed to improve academic and affective needs of students that possess dual identities of Black and gifted. They noted that racial identity significantly
affects these students’ psychological health, motivation, and attitude toward
toward school, citing an example of underachievement and accusations of “acting
White” (p. 21) when they excel. Hughes, Manns, and Ford (2009) also used
Nigrescence Theory to further unpack self-concept (personal and social iden-
tity) to examine racial identity attitudes as a measure of worldviews and aca-
demic performance among high-poverty Black adolescent mothers at risk of not
graduating high school; attitude scores were generally low for participants.
Application of this theory provided additional rigor in the examination of BSSI
as a dual identity, including development at different stages/context as well as
gender considerations.

An Inverted Imposter Syndrome: Superman Syndrome

In an historical review, Pishva (2010) noted that the Imposter Syndrome (Clance &
Imes, 1978) traditionally focuses on self-doubt in the sense of belonging exhibited
among high achievers. The author contends that it may also explain the actions of
Black students that choose to hide their talents and adopt the cool pose (Majors &
Billson, 1993). Majors and Billson (1993) defined cool pose as a presentation of self
that embodied a ritualized form of masculinity that render a message of pride, strength,
and control. The author coined this particular process of hiding talent as The Superman
Syndrome, offering an inverted perspective of imposter syndrome. This perspective
acknowledges that some students hide their natural gifts or talents so that they might
fit into a particular culture or affirm an internalized, negative stereotyped image. This
inverted Imposter Syndrome, or Superman Syndrome, is characterized by the inability
to internalize one’s own successes and the fear that peers will eventually recognize
that he or she no longer belongs or fits into their non-STEM identity. If successful
Black students that pursue STEM fields of study truly believe that their successes are
not attributed to their STEM aptitude or hard work but rather to timing, luck, and abil-
ity to “fool” or outsmart others (Battle & Rotter, 1963; Boaler & Dweck, 2016), then
this, along with other STEM issues, may contribute to an underdeveloped STEM iden-
tity. Langford and Clance (1993) suggested that the goal should be to lessen the stu-
dent’s dependence on others’ positive evaluations for his or her self-esteem and to
build a more internalized sense of self-worth, thus eliminating the need for the mask.

Achievement Motivation Theory

Achievement motivation theory explains the motive to achieve success relative to the
motive to avoid failure (Aikaterini, Lennia, Rafael, Burcin, & Dora, 2016; McClelland,
Atkinson, Clark, & Lowell, 1953). Achievement motivation theory offers some insight
into Black students’ decision to either adopt a “cool pose” (low-achievement motive)
or become high achievers. As such, the author deduces that low-achievement motive
may explain Black students’ choice to disengage and create a self-selected isolation
where one tends to reject others as a survival mechanism to avoid any expected or pos-
sible rejection from others. Consequently, because there is evidence of impact of
resultant achievement motivation on effort, a low-resultant motivation may also play a psychological role in a Black student’s decision to eventually drop out of STEM programs due to feelings of uncertainty about their academic performance and ability or willingness to persist under challenging or hostile conditions. The author further suggests that the shame felt by Black students with low-resultant achievement motivation leads to Imposter Syndrome. Shame may result when the outcome is failure or success because students with low-resultant motivation tend to choose tasks that are either too difficult or too easy.

**STEM Development at Different Levels**

In general, referring back to achievement motivation theory that distinguishes the disparity between perception of ability and other judgments, one is also compelled to consider and question if there are explicit, implicit, or perceived expectations and value systems within school contexts that contribute to imposter syndrome and/or feelings of inadequacy and nonpersistence among Black students in STEM fields of study. In an effort to tease out documented STEM issues among Black students at different developmental stages, research generally suggests two main themes at the heart of STEM identity development—motivation and ability, or lack thereof. Little research focuses on factors that encouraged motivation to pursue and persist over time in a STEM field for underrepresented students. Table 2 provides an annotated bibliography of relevant, empirical studies related to Black student STEM development categorized by associated theories and frameworks. It provides a snapshot of relevant studies that confirms a complex relationship among cognitive, non-cognitive, structural, institutional, and ideological factors influencing patterns of participation and socialization of BSSI.

Gaps in perception of positive STEM experiences and practices begin as early as middle school. External and internal factors play a role in ability perception by the time Black students reach high school. Additional perception of STEM identity, its personal value (benefit), and risks/costs to achieve in STEM affect college STEM retention. The aforementioned synthesis of findings suggests that the components or factors associated with STEM identity may include variables that manifest themselves differently at different stages of development that can be influenced by the environment, internally and externally. Connecting Black students’ cultural values to their STEM interest, talent development, and potential promotes an early and strong development of BSSI that positively affects achievement outcomes (Graham, 2009; Worrell, 2009).

Hernandez, Schultz, Estrada, and Chance, in their 2012 longitudinal study of high-achieving Black and Latino undergraduates in STEM disciplines, claimed Dweck’s (1986) Goal Theory provides a useful framework to understand issues of underrepresentation because it focuses on goal orientations related to individuals’ strive to achieve, their field of interest, and their persistence particularly in academic contexts. They recognized, however, that there exist gaps in literature, despite the current national concern regarding minority STEM interests, achievement, and career
Table 2. STEM at Different Levels: An Annotated Bibliography of Relevant, Empirical Studies Related to Black Student Development.

<table>
<thead>
<tr>
<th>Theory and framework explored</th>
<th>Author(s)</th>
<th>Research methods</th>
<th>Participants</th>
<th>Relevance to STEM development among Black students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement Motivation Theory</td>
<td>Perez, Cromley, and Kaplin (2013)</td>
<td>Semester-long longitudinal study</td>
<td>Diverse undergraduate chemistry student with intentions to leave STEM</td>
<td>Examines the role of identity development, values, and costs in college STEM retention</td>
</tr>
<tr>
<td>Achievement Motivation Theory and Causal Attribution Theory</td>
<td>Weiner and Kukla (1970)</td>
<td>Quantitative: questionnaires; experimental, factorial design</td>
<td>104 male students, ages 16 to 19 years in two German high schools</td>
<td>Considers external (rewards/punishments) and internal (pride/shame) influences on ability (can); perception and motivation (try)</td>
</tr>
<tr>
<td>CRT and Grounded Theory</td>
<td>Wallace and Brand (2012)</td>
<td>Qualitative analysis of the influences on culturally responsive practices</td>
<td>Two middle-school science female teachers (one White with 23 YTE; and Black with 27 YTE) and their students School Demo: 58% White, 39% Black, &lt;1% Asian and/or Latino, 1% American Indian; 50% free or reduced lunch, living below the poverty level</td>
<td>Provides lens for understanding the self-reported and narrated experiences of Black STEM students and practices that close gaps in STEM achievement</td>
</tr>
<tr>
<td>Goal Theory</td>
<td>Hernandez, Schultz, Estrada, and Chance (2012)</td>
<td>Quantitative: survey; longitudinal study</td>
<td>1,420 high-achieving African American and Latino undergraduates in STEM disciplines from 38 different institutions over 3 academic years (pipeline from undergraduate through graduate school and into the professional-working world)</td>
<td>Provides useful framework to understand issues of underrepresentation in STEM from a frame of reference related to goal orientations, approach motivation, and avoidance motivation through three different stages of development</td>
</tr>
<tr>
<td>Imposter Syndrome and Phenomenological Theory</td>
<td>Harvey (1981)</td>
<td>Quantitative: Harvey I-P Questionnaire</td>
<td>30 adults with “adequate” achievement in career areas</td>
<td>Considers concept of self-perceived atypicality that connect sense of belonging to imposter syndrome explained by sex and race</td>
</tr>
<tr>
<td>Transfer and Threshold Theory of Creativity</td>
<td>Coxbill, Chamberlin, and Weatherford (2013)</td>
<td>Mixed-method examination of mathematical products developed by students using MEAs; repeat treatment</td>
<td>39 White students (of 154 in grades K-6) in a rural, intermountain region of the United States, Grade 3: 14B, 10G and Grade 6: 7B, 8G School Demo: 43% free or reduced lunch; less than 25% of parents with bachelor’s degree</td>
<td>Connects Black students’ creative positives and cultural values to their STEM interest, talent development, and potential</td>
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</tbody>
</table>
selection. Yet, they found that growth in a research or scientific identity appeared to “align student goal orientations toward optimal motivation” (Hernandez, Schultz, Estrada, & Chance, 2012, p. 103).

Contrary to the above research, Noble and Morton (2013), in their study regarding mathematical outcomes on National Assessment of Education Progress (NAEP) related to parental and individual experiences, urged that “the focus must shift away from achievement gaps to the realization of these students’ academic potential” (p. 35). They reported that there is a disproportionate amount of research on the deficiency of Black student achievement in comparison with Whites and Asians. They were correct in their assessment that these dominant research perspectives position Black children with an association of failure as a norm that perpetuates negative stereotypes and stereotype threat. Noting this as a disservice to our children in and of itself, Noble and Morton highlighted a different body of research that sought to examine the mathematical experiences within the context of Black student interest and parent engagement. They contended that it would be possible to design educational policies to affect the mathematical literacy of Black students if there was a deeper understanding of the mathematical performance in relation to their interest. This, they believed, would ultimately influence “participation and achievement in advanced mathematics courses, leading to increased readiness for college and increased participation in STEM fields” (p. 31).

Noble and Morton’s (2013) approach provided some real solutions to the achievement-gap dilemma and more importantly, some life-changing interventions that level the playing field and equal access for Black and other underrepresented STEM students. With the lack of relevant research and the disproportionate amount of deficit-focused research (Ford, 2011b; Valencia, 2010), their approach also crafted research practices that were more exploratory, solution-oriented, and culturally responsive.
Two Models That Inform BSSI

Through an extensive review and synthesis of the literature and empirical studies related to Black student identity and STEM issues among Black students, substantial research grounded in critical theories, psychological theories, and achievement motivation theories reveal three major threats to student achievement and persistence in STEM:

1. A lack of reflective identity in STEM—Students do not see many persons within their own race significantly engaged in STEM practices (e.g., little or no parent STEM engagement, underuse of STEM mentor programs),
2. Ineffective and culturally irresponsible STEM pedagogy—STEM knowledge that is not translated for maximum engagement and interest by culturally different students, and
3. Development of a counterproductive and conflicting identity—imposter syndrome, atypical or no sense of belonging, or adoption of “cool pose.”

Two models, Whiting’s (2006a) Scholar Identity and Ford’s (2013) F2AME models, are particularly promising to explore Black students’ STEM identity, motivation, and achievement. They serve as an appropriate, culturally responsive foundation to understand Black male and female scholar identity and to build upon for research regarding BSSI and talent development. Their models offer counter narratives to deficit thinking models and the embedded racial inequality within a color-blind STEM development construct. They situate Black individuals as agents and not victims or inferior beings.

Black Male Scholar Identity Model

The work of Whiting (2006a, 2006b, 2009) has provided a look into a more specific development of Black identity—a scholar identity. Whiting’s scholar identity model, based on several studies with gifted Black males, was originally offered as a guide to help teachers foster scholar identity; he contended that gifted Black males construct their self-concept and racial identity in relation to their perceptions of themselves as students that is further defined by interactions. Adapted from his early work, “Promoting a Scholar Identity Among African American Males: Implications for Gifted Education” (2006b), Whiting outlined nine characteristics of a Black male’s scholar identity: masculinity, racial identity, academic self-confidence, need for achievement, need for affiliation, self-awareness, internal locus of control, willing to make sacrifices, future orientation, self-efficacy—all of which are framed around pillars of family, community, mentoring, and schooling (Whiting, 2009).

Whiting’s work characterized the traits of Black male scholar identity that can be used to combat the negative effects of the defense mechanism that are often adapted by Black (male) students to protect themselves from institutionalized racism. According to Whiting, “one of the most potent and pervasive barriers [in school achievement] is that of social injustices that effectively undermine Black males’ potential, self-perception,
and opportunity to achieve in academic settings” (Whiting, 2009, p. 224). Such educational and social/institutional injustices include oppression, invisibility, marginality, racial profiling, and low-academic track placement. He also noted additional achievement barriers such as identity and self-perception, peer pressures, beliefs about achievement, and notions of masculinity. As a defense mechanism, often times the Black male student adopt a “cool pose” image and intellectual inferior identity that includes a “refusal to assimilate or to otherwise become involved in experiences that could help broaden his personal, social, and political consciousness” (Whiting, 2009, p. 225).

Whiting (2006a) further stated that the effects of a “complex set of negative interactions form a rarely broken vicious cycle” (p. 225), and students can enter this cycle at all skill and academic levels. Drawing on the literature of gifted Black males and achievement, Whiting not only offered solutions for changes but also conceptualized a scholar identity that can be instilled within them and help to foster a positive academic change more readily. By situating his work around gifted Black males and their achievements, Whiting was able to utilize characteristics of Black males as differences rather than deficits. He asserted that the characteristics identified in this model can be generalized to a broader population and, thus, the inclusion of this scholar identity model as a basis to build upon for both Black males and females.

**Black male masculinity identity development.** Confirming the importance of the masculinity perspective that Whiting (2009) discussed in his Black male scholar identity model, Henfield (2012) introduced *Black Masculinity Identity Development* within the cultural framework of phenomenological variant of ecological systems theory (PVEST; meaning-making prior to adulthood grounded in Bronfenbrenner’s popular 1977 ecological model of subsystems and a series of interconnected components). He suggested that this development is critical to improving the scholar identity and support for Black student talent development. Whiting’s and Henfield’s cultural perspective on the biological identity of male and manhood was important to Black identity research because the previous research of masculinity was based on the norms of White men in an attempt to standardize male accomplishments, and the historical significance of oppression and stigmatism that Black males have faced (Henfield, 2012). Regarding Black male masculinity identity development, Henfield asserted that the fascination with Black males who experience enormous barriers for success are often “skewed and biased to the point of promoting a distorted image” (p. 181). Henfield further noted that this stigma of negative images has “evolved into a structural entity” (p. 181), and have been culturally internalized and continue to create difficulties. Henfield helped to contextualize the school-aged development of contemporary Black males through a focus on context-specific experiences that influence beliefs and behaviors; the notion of perception that connects identities to context and behavior is highlighted. Furthermore, Black male students’ positive identity serves as a foundation for building a sense of agency and feeling a sense of belonging in academic settings (Bonner & Bailey, 2006; Douglas, Ivey, & Bishop, 2016).
In a study conducted by Ford and Harris (1997), they concluded that females tend to have multiple and pluralistic identities. Inclusive of racial and gender issues, Ford (2013) has long avowed that more exclusive studies should be conducted that relate to the identity development of Black females only. She claimed that Black females have unique traits, needs, and threats that warrant individual attention. Grounded in Black identity development, Ford’s introduction of the F²AME model expanded on the development of Whiting’s (2006a, 2006b) Black Male Scholar Identity model. F²AME addressed those concerns she had regarding the invisibility of females’ unique, racial and gender needs. F²AME comprises four major achievement components: psychological, social-emotional, academic, and cultural. These components further detailed positive traits of Black females that help them to succeed in achievement settings. This is important because it offers a cultural context of racial and gender identity separate from dominant-group influences. This model may help to reveal characteristics that are especially important for Black females, but not necessarily other groups.

Just as color-blind ideology associates color with negative characteristics and invalidates one’s racial identity, a gender-neutral mind-set that dismisses the role of gender (Tinainen & Berki, 2017) especially within the STEM field does the same. Men and women of color will experience the White-male dominated STEM environment differently. Women, as an additional underrepresented population in STEM, experience additional gender-based oppression. For them, gender further magnifies the
race-based stereotype threat with imposter syndrome within a “chilly” STEM climate embedded with historical practices of race and gender bias (Collins et al., 2017).

**Conceptualizing Key Factors of a BSSI**

As illustrated in Figures 2 and 3, Whiting’s Black Male Scholar Identity model and Ford’s F2AME model account for the complexity, different developmental stages, and multidimensional aspects of positive Black student identity development that is nonlinear and culturally relevant. Utilizing a positive lens contextualized around family, community, mentors, and schooling makes them an even more attractive model to address identity development and nurture achievement. Furthermore, examination based on personal STEM reflection, observations, and case studies reaffirmed Whiting’s and Ford’s gender-based, racial-scholar perspective specific to STEM discipline. It revealed distinguishable identification traits that affect Black students’ STEM identity development. Thus, the contextual conceptualization of BSSI is posed as an extension of the emerging nature of Black students’ valued racial and gender identity. BSSI is offered as a framework for understanding the critical characteristics that are present for Black students that already show a high interest in STEM for the purpose of uncovering and developing their STEM potential within a formal setting, even though STEM achievement is not limited to that which is shown in school.

*Figure 3. Ford’s female achievement model for excellence. Source. Reprinted with permission. Ford (2013; http://www.drdonnyford.com/#!black-females/c1zop).*
Reiterating that the development of students’ STEM identity is the result of reciprocal interactions among various psychological factors, individual behaviors, and the outside environment, the author posits that BSSI development is characterized by a cyclic attitude toward one’s STEM self-concept, sense of belonging in STEM fields of study or discipline, and the perception of one’s own STEM cognitive ability. All of these, with gender-based, racial identity at the core, affect decisions to pursue STEM interests. With a valued race and gender at the core of their identity, and at different developmental stages, Figure 4 provides a visual representation of how Black students internalize four basic questions that influence their motivation to learn and persist in STEM areas:

1. Do I belong in a STEM field? (Reflective Identity)
2. Can I succeed in a STEM field? (Competence/Ability)
3. Do I want to succeed in a STEM field? (Value/Interest)
4. What must I do to succeed in a STEM field? (Assimilation)

The answers to these questions are interconnected in a way that compels the construction of an academic/scholar identity that greatly influences the way in which they come to understand themselves within their own culture (internal environment) and in
relation to the institution of schooling (external environment), which consequently shape their occupational identity and career choices.

**Reflective Identity**

When deciding whether or not they belong in the STEM field, it is imperative that students see others that look like them to break any socialized belief barriers about possibilities of success. If there are no people of the same gender and race with which they identify, then they will also question their sense of belonging. This is especially true if those people are not from their most inner circle and communities with which they identify. In such cases, STEM mentors that are willing to work with the student within their own culture helps to strengthen that identity. It is equally important that Black students see STEM educators and other practitioners in the field of STEM reflected in the curriculum.

**Competence/Ability**

No amount of praise or encouragement will ever equate to one’s own perception of his or her ability. Confidence in one’s own knowledge and cognitive ability is key in STEM, which is typically delivered as advanced academics and concepts. The answer to this question lies in opportunities for success in ways that students find most intriguing. It is important to note that these successes may arise in the student’s personal space and cultural environment as informal learning and problem-solving activities, even if they are not categorized as STEM. Extending those successes from home and in the community, we must help students to relate those informal activities to STEM as well as provide similar successes at school and other external environments. The more genuine, diverse successes that they conquer, the more confidence they will have in their own ability.

**Value/Interest**

In addition to increased confidence, more value is given to the STEM field of study in terms of personal interest and cultural values as students experience genuine successes. This is especially important if there seems to be low interest or cultural value to STEM field of study as defined and/or exhibited by the external environment. As an example, students may learn in school how the employment of STEM knowledge and skills can increase our study of space. However, without pronounced personal interest, if they never see astronauts that look like them nor understand how that career field will affect their innermost circle of friends and family, there is decreased value to that field of study for them. On the contrary, if there is a perception that the external environment values the STEM in the way it is within the student’s internal environment, an increased value or interest in STEM may occur.
Assimilation

Already a component of Black racial identity, the student conducts an evaluation of what one has to do to succeed or fit into the STEM culture. If assimilation within the STEM culture includes any perception of conflict to their own core identity, students will again begin to question whether or not they belong. Similarly, if the benefit of achievement within the STEM culture puts themselves at risk of being distanced from their core identity or culture, they will begin to have doubts about where they fit. Ultimately, the question of “what must I do to succeed?” becomes question of “can I still be myself and be accepted for who I am or must I pretend to be or act like someone else?” Resulting defense mechanisms act as survival techniques that buffer the conflicts between institutionalized and cultural values or expectations (Whiting, 2009), but might also hinder a manifestation of positive STEM characteristics. This possibility upholds the call for an examination of such STEM achievement among Black students from within their own cultural practices and social settings.

Implications

It is important for all stakeholders to understand that factors exist that either contribute to and/or detract from the development of a STEM identity. To distinguish between these, it is also important to also recognize the following points:

1. There has not been significant progress in bridging the underrepresented gaps in STEM workforce for over 25 years.
2. A color-blind or “one size fits all” STEM curriculum and talent development programming is innately embedded with racial inequalities.
3. Race is a socialized construct that includes and is situated within the context of other identities such as gender and occupational identity.
4. A STEM identity is the way in which one views himself or herself based on a belief in his or her ability to utilize STEM skills and/or STEM talents to become a STEM professional or STEM innovator.
5. BSSI is offered as a counter narrative to deficit thinking and racial inequalities surrounding STEM identity and talent development.
6. Promotion of an early and strong development of BSSI that positively affects achievement outcomes by connecting Black students’ cultural values to their STEM interest, talent development, and potential is essential.

Implications for Parents and Teachers

From a student’s solidified self-concept and perspective, we will find ourselves better equipped to cosign on their identity, and appropriately develop their talents. This includes, but is not limited to, adequately addressing any mismatch, racial inequalities, and disregard that might be present in STEM curriculum, instructional approaches, psychosocial support, and working environments.
Collins and Fields-Smith (under review) shared examples of day-to-day practices of parent engagement of Black students that fostered STEM identity and served as an additive to the realm of STEM talent development outside of school, defined by and experienced within the home. These practices included informal and problem-based STEM learning through solution-oriented inquiry related to home-based affairs. Activities were naturally framed by family and student values. The term parent was inclusive of biological as well as nonbiological guardians of children such as adoptive parents, foster parents, and grandparents. The authors noted that the parent-engaged and home- and community-based STEM experiences fostered intrinsic motivation for STEM interest, STEM academic success, and STEM talent development in school. However, the authors also noted that teachers might not have any idea of the rich STEM-related activities or “hidden talents” exhibited within the home and the community. As such, a recommendation to decrease the cultural discontinuity between home and school was offered as a solution to develop more equitable school practices and increased student outcomes for Black students in STEM.

In the preface of her text, *Multicultural Gifted Education* (2011a), Ford cited the American Association of Colleges for Teacher Education (AACTE) in its acknowledgment of existing difficulties for cultural and linguistic diverse (CLD) students to integrate their worldviews, or manifestation of racial identity. She asserted that implications call for cultural-competent teachers to provide a culturally responsive learning environment (Ford, 2011a). “To develop equitable outcomes, we need more knowledge than just the correct cultural interpretation . . . it is also necessary to gain an appreciation of the value of the learner” (McAnany, 2009, p. 7). Educators can address the inequitable STEM development gaps between White students and students of color by first recognizing that equal (sameness) is not always equitable, and even more so acknowledging that dominant-oriented approach to learning implicitly pigeonholes Black student differences in manifestation of STEM interest and talent as deficits. A color-blind approach to STEM talent development dismisses the cultural attributes as well as the underlying issues (i.e., causes, traits, reactions) that influence Black students’ STEM identity development.

**Future Research**

As this review of literature revealed, there is a dearth of research examining identity development specific to Black students within STEM disciplines. Similar to the complexity of a Black students’ scholar identity, a conceptualized framework of Black students’ STEM identity compels researchers to consider contextual STEM interest, values, and issues among Black males and females to fully appreciate how the nature of racial and cultural identity informs the construct of BSSI. As such, the introduction of this model serves as a framework in a call for action to redress the racial and gender inequalities in current STEM talent development that contribute to underrepresentation throughout STEM pipeline. STEM researchers could conduct empirical studies to examine the extent to which BSSI development is characterized by a cyclic attitude
toward one’s STEM self-concept, sense of belonging in STEM fields of study or discipline, and the perception of one’s own STEM cognitive ability.

**Considerations for Students of More Fluid Color and Gender**

Acknowledging the STEM talent and achievement gaps categorized by race and gender (National Science Board, 2016), I provided a review of the literature to understand critical aspects of racial identity, motivation, and STEM related to Black students. I do not posit transferability, or generalizability, to other settings, context, or populations. Alternatively, that responsibility is deferred to the reader (Lincoln & Guba, 1985) with acknowledgment that further research is warranted to include other students of color.

As such, to present this model for future research to include collection from larger institutional and government database, categorical identification is necessary to complement their datasets. Although the author has clarified and iterated race as a social construct to include that which one closest identifies with in terms of culture, heritage, and lived experiences, the inclusiveness of a multicultural perspective compels us to also consider biracial and multiracial identity. To address problems of underrepresentation, an argument can be made for a more fluid and less categorical approach to race, gender, and STEM identity. As the research for multiracial identity with an emphasis on positive identity is even more negligible, BSSI serves as a framework by which to extend the research.

**Conclusion**

It is imperative that, in identification and development, we start from the perspective of personal, cultural, and social capital instead of deficit and “brokenness.” Within this perspective, we can address the gaps in the STEM pipeline and get to the root causes for lack of success and persistence for those underrepresented students that show significant interest and/or achievement in STEM. This contextual model for Black STEM student identity considers key factors—cultural values, personal interest, perceived competence and abilities, and sense of belonging—that contribute to the development of a STEM identity. It extends two race- and gender-based models for scholar identity development. It serves as an appropriate, culturally responsive foundation for the intersection of Black student identity and STEM talent development.

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About the Author

**Kristina Henry Collins** currently serves as a core talent development faculty for curriculum and instruction at Texas State University, San Marcos. She completed her doctoral work with a PhD in educational psychology at The University of Georgia where she also earned her EdS degree, specializing in gifted and creative education (GCE) and educational leadership. She also holds an MSEd degree in mathematics (Jacksonville State University), BS degree in engineering (University of Alabama), and a military science diploma (U.S. Navy) in cryptology and electronic surveillance with more than 20 years of educational teaching and leadership experience. Her research interests include science, technology, engineering, and mathematics (STEM) talent development, multicultural gifted education, and STEM mentoring across the life span.