



The Influence of Racial and Mathematical Identities on African American Male Engineering Transfer Students

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Abstract

In 2012, African American male (AAM) students made up 4% of the currently enrolled male college students in engineering according to the National Science Foundation (2012). AAM students often begin their higher education journey at community colleges. According to the 2011 American Association of Community Colleges report, 44% of African American students attend community colleges. Many community college students hope to transfer into 4-year institution to complete a baccalaureate degree.

There is a desire and determination to facilitate student transfer from community colleges into 4-year institutions. That being acknowledged, it is hard to miss the deficit lens through which AAM student populations are viewed. AAM students are often portrayed as victims; blamed for their lack of success, persistence to degree, or not transferring to a 4-year institution; or portrayed as academically underprepared and require taking academic developmental courses^{1,2}. These unsuccessful performances, project blame or fault on individual students due to delaying their academic goals attributed to economical and personal obligations.

This research critically explores some pathways of AAM engineering transfer students through the conceptual lens of racial and mathematical identities. This work focuses on students who are currently enrolled at 4-year institutions and who have attended community colleges at one point in their academic careers in the pursuit of engineering degrees.

Racial identity development research literature indicates that racial identity is based on an individual's perception that is shared by a common racial heritage with a particular group^{3,4,5,6}. Research shows that African American students who have a strong racial identity are better equipped to navigate negative climates, deal with racism, and tend to have strong self-esteem^{7,8,9,10}.

Mathematical identities are constructs that look at the individual's beliefs, attitudes and feelings towards mathematics^{11,12,13}. These identities describe the student's ability to perform mathematics and how the student's experience learning mathematics as a process where the classroom environment is treated as a broad context. Cultural models are often used to represent mathematical identity constructs, such as "math is hard" and "math is for geeks"¹². These cultural models can enhance or hinder student's relationship with mathematics^{11,12}.

The theoretical significance of this work is to tighten existing literature gaps in underrepresented students at community colleges and transfer students into 4-year institutions. It also contributes to the racial and mathematical identities constructs; and provides practical significance with the potential to increase engineering enrollment in 2- and 4-year institutions, increase underrepresented participants' understanding and awareness of their own racial and mathematical identities, and inform and improve professional development of math educators in academic settings.

This work consist of an exhaustive review of peer-reviewed journals and scholarly research work related to AAM engineering transfer students, with a major focus on racial and mathematical identity constructs. Major themes and sub-themes that run through these articles will be discussed in detail in this work to bring meaning and closer answers to the question of how do racial and mathematical identities shape the transfer experience of African American engineering male students who attend 4-year institutions. The author includes their own critique of this body of literature.

1. Introduction

This work provides a review of the literature around five scholarly topics: racial identity development theory, mathematical identity in higher education, and transfer and engineering experience.

The strands of literature that is used in this study intersect at race and racism and understanding the overall experiences of AAMs in engineering education. Largely perceived from a deficit model, AAMs face obstacles to successfully transfer from CCs, navigate engineering curriculum, and successfully persist in 4-year institutions. What higher education systems promote the successful transfer of students from CCs into 4-year institutions? What other factors help to guide AAM students through and along the way? Is the potential to promote the development of positive mathematical and racial identities a predictive factor towards persistence in engineering education?

2. Racial Identity

Cultural researchers explore the ways in which AA students racial identities and racialized opportunities and expectations have implications for their academic achievement in mathematics^{14,15}. Race and racism often are defined within a monoracial paradigm as “contextual, situational, and variable”¹⁶ (p. 9). Researchers have shown that gender, class, ability, and the spirituality of individuals all mold their lived experiences and become even more complicated based on the variations of skin tone and how the individuals identify culturally or ethnically^{3,15,17}. Racial identity’s role can be seen through societal and personal meanings of race influencing the person’s self-concept and consequent action and behavior^{3,5,18}. Research in this area continues to emerge, however, it points to shared findings that a less prominent racial identity of AA is related to weaker academic performances, whereas a strong salient racial identity is lined to stronger academic performances^{8,19,20,21,22,23}.

Racial identity development research literature indicates that racial identity is based on the individual’s perception that is shared by a common racial heritage with a particular group^{3,4,5,6}. Additionally, AA students who carry realistic beliefs about their race tend to be protective in their thinking and actions⁸. Research shows that AA students who have a strong racial identity are better equipped to navigate negative climates, deal with racism, and tend to have strong self-esteem^{7,8,9,10}.

2.1 Racial Identity Development Models

Cross's Nigrescence model was developed for racial identity development of AAs. In this model, AAs experience different stages of racial identity developments^{3,24}. Cross's framework defines individual's racial identity development through various nonlinear stages of understanding their own racial identity from childhood to adulthood. According to Cross's model, individual's progress from multiple stages of the model, from race having little relevance to an identity in which race is very salient and fully present³. For example, during the preencounter stage individual's view of race has a less important part of their identity. While during the encounter stage the individual's racial experiences prompt a reexamination of racial challenges. In the immersion-emersion stage, AA individual become pro AA and against Caucasian individuals. While during the internalization-commitment stage, AA individual are satisfied and secure about being AA and welcome other racial and ethnic groups; in this stage, AA individual applies internalized racial identities into behaviors and actions³. The frequently used instrument to operationalize Cross's model is called the Racial Identity Attitude Scale (RIAS), typically to measure a direct relationship between racial identity and outcomes for AAs²⁴.

Extending Cross' Nigrescence model, Helm's model measures "an individual's attitudes, thoughts, feelings, and behaviors toward oneself and others with respect to racial group membership"⁸ (p. 34). Helm's model describes racial identity development of AAs as a movement "from having self-degrading racial identity attitudes to self-enhancing racial identity attitudes"⁸ (p. 34), where individuals feel secure about their own racial group and appreciate other racial and ethnic groups. The challenge with Cross and Helm's theoretical models is that they both do not consider holistic individuals with their other identities. Therefore a use of a multifaceted model for racial identity development seems to address this issue.

The Multidimensional Model of Racial Identity (MMRI) was first introduced by Sellers and others in the late 1990s; MMRI treats each AA individual uniquely with different thoughts, cultural views, and behaviors. This model provides an integrated view of racial identity development of AAs by placing more emphasis on situational and cognitive elements and focusing on their self-concepts related to their membership within their race^{6,8}.

Similar to other racial identity development models, the MMRI consists of dimensions of racial identity: the salience of identity; the centrality of the identity, the ideology associated with the identity, and the regard to which the person holds AAs. The salience and centrality dimensions address the significance of race as defined by the individual; while the racial ideology and regard dimensions address the qualitative meaning that the individuals ascribe to being black.

The instrument that is commonly used by researchers to measure three MMRI dimensions is called the Multidimensional Inventory of Black Identity (MIBI). It emphasizes the

individual's self-concept about race and ethnicity. MIBI exposes the situational and contextual issues shaping the ethnic and racial identity of individuals^{3,8,17,25}. McGee further explained that "the salience of race is conceptualized differently for African Americans according to their individual beliefs and that racial identity cannot be understood without examining the larger social context"⁸ (p. 36).

Research on racial identity development has demonstrated that AA students with positive identity toward their racial group and realistic perceptions of racism are better equipped, in terms of overall self-concept and ability, to combat racism experiences and negative barriers^{26,27}. For example, O'Connor found that the low income, high-achieving AA high school students articulated with acute recognition the relationship between oppressive social and educational structures and their agency²⁶. Similarly, Altschul, Oyserman, and Bybee showed that AAs receive higher grades in school if they connect their racial identity with academics²⁸. Rowley, Sellers, Chavous, and Smith reported that private regard is positively associated with self-esteem among young AAMs¹⁸.

3. Mathematical Identity

Mathematical identities are constructs that look at the individual's beliefs, attitudes and feelings towards mathematics^{12,13,29}. Mathematical identities describe the students' ability to perform mathematics and how the students experience learning mathematics as a process where the classroom environment is treated as a broad context. Cultural models are often used to represent mathematical identity constructs, such as "math is hard" and "math is for geeks"¹². These cultural models either enhance or hinder the individual learner's relationship with mathematics. For instance, adult learners who have a strong relationship and identify strongly with mathematics tend to utilize mathematics in a different sociocultural context^{12,29}.

However, students that are academically underachieving in mathematics, tend to develop weak relationships with mathematics. They tend to only see mathematics' application inside the classroom and in a more abstract sense. They are inclined to focus on procedural knowledge associated with exams and passing the standardized remedial mathematics test rather than learn new mathematics concepts with higher level knowledge. These students only want to know the steps to solve problems for the test and nothing beyond that. They do not see mathematics application in solving real-world problems, but rather see it as unrelated to their daily life activities. In simplicity, the mathematically underachieving students may only see the use of math inside of the classroom and for passing grade tests. Beyond the classroom, mathematics is irrelevant and uncool^{29,30}.

It is the school, family, and community's responsibility to sort through how to influence the development of African American (AA) students' identities of achievement to encourage them to see how math relates to what they are doing right now and how it is an essential foundation for everything to set the belief that one's mathematical experiences are a fundamental

contributor to one's identity and sense of self, and to maintain and merge positive identities in the contexts of being an AAM and being a learner of mathematics. It is a struggle that is brought on by a number of forces that racialized the life and mathematical experiences of AAM students in community colleges³.

Martin expressed through his work a common thread among AA adult participants' roles and having strong beliefs about their racial and status identities as defined by dominant culture³⁰. Success stories of AAMs in mathematics education can provide the voice and stories that Critical Race Theory (CRT) scholarship stress to counteract the stories of the dominant group. Dixson and Rousseau described the dominant group as those who tell stories designed to:

remind it of its identity in relation to outgroups and provide a form of shared reality in which its own superior position is seen as natural... We must learn to trust our own senses, feelings, and experiences, to give them authority, even in the face of dominant accounts of social reality that claim universality... Thus, voice scholarship provides a counterstory to counteract or challenge the dominant story³¹ (p. 35).

AAs racial and status identities seem to be defined by status quo to create real and perceived boundaries that limit their opportunities in the larger social structure, including mathematics. Martin noted that those who overcame these obstacles and had success stories to share with mathematics did not accept these preset boundaries passively but rather exhibited a range of positive, agency-related behaviors³⁰. They took the negative connotations assigned to them as being AA both in and outside of their classrooms; they maintained a strong racial identity and a firm belief in the importance of mathematics literacy for both themselves and their kinsmen. The struggles to transcend these boundaries also reveal how closely their identities as AAs and identities as learners of mathematics are linked. These struggles for mathematical literacy continued to shape their sense of self as AAs. The strong racial identity made AAs more committed in their struggle for mathematics literacy³⁰.

This is analogous to a novice runner who joins a runner's club, who at first had to struggle to overcome the physical and mental limitations for sticking with the routine and practice running, overcoming internal and external boundaries to overcome these struggles. Once the beginning runner commits to the process of overcoming these barriers, the sky then becomes the limit; they are then able to continue to push themselves for success and run and complete marathons. The mental and verbal strategies that some runners use to assist and guide the new and advanced runners to continue to push together for this struggle of becoming a fast runner creates a sense of empowerment, working as a team, as a community of practice to help one another to reach the impossible and become an expert runner. Not every runner will stay committed to this club. Some will come and some will go; some will succeed independently, and some will not. As cited by Perry, Martin's interactions with AA adults reveal the following:

That the experiences and motivations characterizing African American struggle for mathematics literacy often extend well beyond the school context. On the one hand, this struggle is often linked to a desire for meaningful participation in the larger opportunity structure. On the other hand, it is emblematic of a philosophy of education that has been passed down in the African American narrative tradition: literacy for freedom and freedom for literacy. [This narrative tradition includes] stories about struggles for literacy, stories and the purpose of literacy, stories about what people were willing to do to become literate, and stories about how people became literate so that they could be somebody³² (p.92).

These stories are also important because they “link literacy and education to the social identity of African Americans, to the very notion of what it meant to be African American”³² (p. 105).

According to Anderson, one dimension of learning mathematics is when the individual develops an identity as a math learner³³. AAMs may be required to enroll in remedial mathematics classes; however, the contribution of these classes on the student’s mathematical identity is at its initial development, also known as mathematical identity through alignment³³. As the students engage in the learning process of mathematics, the interactive activities may appeal to them, and their identity is further developed through engagement. Similarly, students interested in engineering may envision their participation in mathematics classes as preparation for their future career as engineers. Mathematics is both a requirement for entrance into the career and a necessary knowledge to pursue the career. Thus, identity in mathematics is maintained through both imagination and alignment³³.

4. African American Males Academic Success at Community Colleges

AAM students in community colleges can be studied through persistence and academic success literature. AAM students’ academic persistence, graduation, and success rate entering CCs are alarming. The US Department of Education (2006) reported that a one year persistence rates for AAM students show low rates to continue their academic studies at CCs. AAMs have approximately 74% first year persistence rate, compared to that of Caucasian (75%), Hispanic males (77%), and Asian American Males (91%).

In addition, AAM students have the lowest graduation rate of any other racial category, where only 16% graduate in three years. Their academic success has also been shown to be dismal with an average GPA of 2.64 in comparison to their Caucasian males (2.90), Hispanic (2.75), and Asian American males (2.84).

As educators and researchers, we must be cognizant of how persistence and academic success are being measured and how they can be over critical of CCs. It is important to note the lack of documented and published literature examining the persistence and academic success of AAM students in CCs. AAM students that attend CCs may be less engaged in campus activities

due to lower social integration than seen at four-year institutions. Therefore, there is a great need to expand the literature around AAM students attending CCs and what contextual factors account for their academic success.

In addition to student persistence academic success for AAM students at CCs is mainly documented in doctoral dissertations with minimal occurrence in peer reviewed journal articles³⁴. AAM students at CCs bring to their learning social, economic, and academic attributes. Research studies indicate that factors associated with academic success for AAMs at CCs are influenced by personal, institutional, academic, and psychological factors^{34,35,36,37,38,39,40,41,42,43,44}.

Wood developed a conceptual model as part of his doctoral dissertation around the academic success of AAM students at the community college³⁴. Wood's work consisted of a meta-analysis of 50 peer-reviewed articles around AAM students in CCs that guided his work. Wood conducted in-depth semi-structured interviews with 28 AAM students attending CCs in Arizona. According to Wood, the factors that influence the academic success of AAM students at the community college are: transportation, life stability, family support, finances, employment, religion, and peer support³⁴.

Additional research extends the seven personal factors discussed in Wood's conceptual model⁴⁵. Wood and Palmer demonstrated the relationship between AAM student success in CCs and personal goals set by the students⁴⁵. Personal goals are life goals of AAM students that promote their academic and psychological development. They are conscious and non-academic goals pursued by students and include goals pertaining to their intellect, social, political, economic, and spiritual goals. The three statistically significant personal goals pertaining for AAM students in CCs included: being a community leader, having financial prosperity, and experiencing residential mobility⁴⁵.

5. African American Male Transfer Students' Academic Experiences in Engineering

Approximately 20% of engineers that hold a higher education degree started their academic journey at a community college⁴⁶. In addition, 40% of those with a bachelor's and master's degree in engineering from 1999 to 2000 attended community colleges as part of their academic journey⁴⁷. The main reason students choose to begin their higher education pathway with community colleges is the need to reduce financial costs of their education. According to a 2005 National Research Council study, community colleges have not achieved their full potential for the following reasons:

- (1) a lack of understanding among parents, teachers, counselors, and students of the effectiveness of community colleges in producing engineering graduates;
- (2) less than effective articulation agreements (policies and program designed to foster transfer) between community colleges and four-year institutions; and

(3) a lack of cooperation and coordination among high schools, community colleges, four-year institution, and state higher-education agencies (p. 2).

According to the same report, effective partnership between community colleges and four-year institutions provide the following objectives and goals:

- 1) To promote an increase in the recruitment, retention, and matriculation of minority male students in STEM fields at two- and four-year institutions with an ultimate goal of increasing the numbers of minority males who successfully complete a STEM degree.
- 2) To enhance existing collaborations among community colleges and four-year institutions to build and maintain a pathway for minority males in STEM disciplines.
- 3) To develop multifaceted pathways from community colleges, including collaboration with four-year institutions on coursework design in science and mathematics.

The same report stresses the importance of increasing students awareness of the opportunities that community colleges offer their engineering students, including financial assistance in reducing college cost, and providing flexible course schedules. In addition, through workshops and orientations, the community colleges can provide both students and parents with concrete information and messages to overcome the widespread belief that their education is inferior to that of four-year colleges and universities. According to a 1998 Department of Education longitudinal study on women and men majoring in engineering, it is the student's perception about their credit overloads in engineering that influence their decisions to leave engineering due to the high ratio of classroom, laboratory, and study hours to credit awarded. Engineering pathways are used rather than pipelines to describe the students trajectory and storyline narrated by the individual student.

It is not a paved roadway with exit ramps at set intervals, rather a trail that one constructs along contours of the terrain. One can wander away from a rough trail marked by the footsteps of predecessors, finding another pathway that may fit one's proclivities and changing values there from here. And "there" is not necessarily an immutable, fixed place. A path through higher education, after all, is not merely one of curriculum. It is also very much about student growth, the discovery of interest, the sanding down of sharp edges, the construction of refuges, the honing of negotiating skills, and the development of behaviors and stances to serve in the workplace, family formation, and community life⁴⁸ (p. 10).

The engineering pathways describe the texture of the student's backgrounds and experience as they partake their journey on their paths to discovery, often taking meaningful detours. As educational researchers, we can improve the signs along their engineering pathways, and in the case of AAMs in engineering, improve the quality of instruction and professorial sensitivity to minority students. Engineering students are not all the same beings. They are not all tinkers. Engineering as a field, needs to be a choice that the students make

where it provides relevancy to a broad group of audiences with a full portfolio of richness of its culture and practice, and with a clear map of its intersections with and divergences for bench science.

6. Conclusion

There are no quick fixes for meeting the needs of AAM transfer students majoring in engineering at four-year institutions. Rather, meeting classroom needs requires a sustained process with educators remaining consistent throughout. This challenge did not come about overnight and neither will its solution. Educators must stay encouraged. It will take time and creative ways to address this massive challenge. We need to realize that lack of proficiency in math for minority males is a symptom of much deeper murky problems that have gone ignored, unaddressed, and unmet for way too long. By identifying some of these problems and providing solutions to educators and administrators, we might get closer to closing the gap in the shortage of minority male students transferring from CCs into engineering majors at 4-year institutions.

Some educators and administrators may state that change has to happen from within the individual adult learner. Further, they believe that if the students do not do their work and are unmotivated and unwilling to participate in the learning process, then there is no point of providing support and interventions for them. What the educators and administrators might not see is the student's daily difficult grind. Each adult student has a unique context that is regularly surrounded with negativity and other perversities. At minimum, the educators and administrators must provide a welcoming and edifying environment to the students; a safe haven from the "craziness". Minority male students who choose to engage in the learning process inside of the classroom may be ostracized or labeled by their peers as acting white, especially in fields like engineering and science^{12,49}. But, if they attend math and engineering class and participate in meaningful problem-solving and critical-thinking discussions, then transformation takes place; their racial and mathematical identities slowly change.

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