



## **Engineering Identity of Black and Hispanic Undergraduates: The Impact of Minority Serving Institutions**

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## Abstract

Despite the fact that Black students at Historically Black Colleges and Universities (HBCUs) are more likely to become professionals than their peers at Predominantly White Institutions (PWIs), and that Hispanic Serving Institutions (HSIs) graduate the highest number of Hispanic students in the United States, much of the research on the experiences of minority engineering undergraduates has been conducted at PWIs. This National Science Foundation-funded study examined Black and Hispanic engineering undergraduates at Minority Serving Institutions (MSIs) to understand how their engineering identities developed while attending an MSI. This study used a mixed-methods design, collecting quantitative data through surveys and qualitative data through semi-structured interviews. Participants (N=202) were male and female engineering sophomores, including Black students attending two HBCUs and Hispanic students attending two HSIs. Both Black and Hispanic engineering undergraduates reported benefits of attending MSIs. These benefits included having a curriculum that provided challenging coursework, professors who were invested in their success, peers who were like family, and the reputation of their institution for graduating well-prepared minority students in engineering. Data analysis found that the majority of the students reported having an engineering identity. Furthermore, the experiences of these minority students impacted their engineering identity in ways that have not been cited in previous research.

## Introduction

Increasingly, engineers are becoming a part of a global community, and thus diversity across race, ethnicities and gender is becoming more prevalent in the United States. How students begin to identify as engineers may be impacted by their race, gender or ethnicity. As such, it is important for us to understand how an engineering identity develops and how it may influence retention, continued matriculation and completion of an engineering degree<sup>3</sup>. In the U.S., Black and Hispanic engineering students are retained at a rate much lower than their White or Asian counterparts<sup>1, 2</sup>. It is important to investigate Black and Hispanic American undergraduate students' engineering identities because these students have remained underrepresented in engineering disciplines. That is to say, the perceived categories of "Black," "Hispanic American," and "engineer" do not often intersect<sup>4, 5</sup>. The vast majority of research studies on engineering students that include Black or Hispanic students have been conducted on the campuses of Predominantly White Institutions (PWIs), despite the fact that Black students are more likely to attend and successfully graduate from Historically Black Colleges and Universities (HBCUs), and Hispanic Serving Institutions (HSIs) graduate the greatest number of Hispanic students in the United States<sup>6, 7</sup>. Thus, it is apropos to conduct a study of Black and Hispanic American students at Minority Serving Institutions (MSIs) where they are the majority and where they are most likely to be successful. The purpose of this study is to investigate how the engineering identities of Black and Hispanic students develop while attending an MSI.

Past research has found minority students are at a greater risk for not completing an engineering undergraduate program than their White counterparts<sup>1</sup>. Among the problems that minority

students report is dissatisfaction with the impersonal and competitive atmosphere of engineering institutions<sup>8</sup>. As early as 1997, researchers noted that over 50 percent of engineering undergraduates failed to graduate as engineers<sup>9</sup>. In the early 2000s, it was found that while the number of engineering degrees awarded by universities in the United States had increased, the proportions of Black and Hispanic students receiving these degrees experienced a small decline<sup>10, 11</sup>. Bonous-Hammarth<sup>12</sup> conducted a study of undergraduate enrollment and retention in STEM programs that found Black, American Indian, and Hispanic students were less likely to enter STEM majors than White and Asian American students, and that those who did enter were also less likely to receive a degree. Bonous-Hammarth's<sup>12</sup> research as well as several other studies reveal that the pre-enrollment characteristics of students such as high school academic average, courses taken in high school (particularly mathematics and science courses), SAT/ACT scores, cultural identification and commitment, and interest in STEM areas predict retention rates of minority students in science and engineering majors<sup>12, 13, 14, 15</sup>. Tinto<sup>8</sup> found that post enrollment phenomena, such student academic and social integration in the institution of higher education, generally, and integration into the academic program, specifically, predicts the retention rates of minority students as well<sup>8, 16</sup>.

Factors such as cultural identification, commitment and Tinto's<sup>8</sup> model of social integration into the institution of higher education suggest that Black students may be more likely to attend and graduate from HBCUs. Controlling for pre-collegiate characteristics and the academic selectivity of the institutions, researchers have suggested that attending an HBCU is positively associated with Black students remaining in college and earning a bachelor's degree<sup>6, 18</sup>. Additionally, Allen<sup>19</sup> noted that the "fit" between Black students and higher education is more favorable at HBCUs. Also, Wenglinsky<sup>17</sup> found that Black students at Black institutions are more likely to become professionals<sup>6</sup>.

Just as Black students are more likely to benefit from attending HBCUs than PWIs, Hispanic students are likely to find similar benefits attending HSIs. In 2004, there were 366 Hispanic Serving Institutions in the United States; an increase of almost three-fold from the number ten years earlier. HSIs enrolled 63% of all Hispanic students in higher education and 27% of all underrepresented minority students studying in U.S. colleges and universities<sup>20</sup>. As early as 1992, the National Center for Educational Statistics noted that the persistence rate of Hispanic students in higher education was the highest of any minority group. The factors that seemed to correlate with the academic persistence of Hispanic students were their perceptions of the university environment<sup>21</sup> and cultural congruity<sup>22</sup>. Tinto's model on integration and the retention and graduation rates of minority students at MSIs suggest that research exploring Black and Hispanic students attending MSIs may be more fruitful in understanding engineering identity development as compared to minority students attending PWIs. The influence that attending an MSI has on retention for minority students may also extend to the development of students' engineering identity in that a stable identity is more likely to lead to persistence in the major.

## **Engineering Identity**

Gee's theory of identity states that identity encompasses the kind of person one strives to be<sup>23, 24</sup>. Buxton et al.<sup>25</sup> maintain that while that may be the case, one cannot have an identity in a vacuum; others must validate that identity. Therefore, one must demonstrate competence in

regards to that identity. When investigating a science identity, Carlone and Johnson<sup>26</sup> applied these rules for identity attainment, stating that science identity development results from competence, performance, and recognition. In other words, in order for one to develop and maintain a science identity, one must understand a particular discipline of science, demonstrate adequate performance in that discipline of science, and be recognized by others for this competence and adequate performance<sup>27</sup>. However, Carlone and Johnson also noted that identity development is also not without cultural production—that the culture in which the identity is developed influences the identity development. Carlone and Johnson’s theoretical framework can be applied to engineering identity development. In this case, we focus on the cultural context in which the identity develops, namely the MSI campus.

Researchers have conducted studies on identity development of engineering students, specifically. They found that three factors influence the development of an engineering identity, (1) how engineering is understood as a science, (2) the rules that govern the behavior of an engineer, and (3) the environmental setting of the institution in which one learns to become an engineer<sup>28, 29</sup>. It is this latter factor that we have examined in this study. Taken together, the importance of studying the development of an engineering identity taken on by minority students at institutions that specifically serve these students is undeniable.

## **Purpose**

The undergirding research question in this study is: “How do underrepresented minority students come to identify themselves as engineers?” More specifically, to understand the influence attending an MSI has on the development of an engineering identity for Black and Hispanic students by investigating how interactions with faculty, peers, and other aspects of their respective institutions relate to their developing engineering identity. Tinto’s<sup>3</sup> model of integration and the burgeoning theory of engineering identity<sup>28</sup> guide this study in that Tinto’s model describes how the environment of an institution, including curriculum and interaction with faculty and peers, influences students’ academic experience and how this can go on to influence retention. The theory of engineering identity explains how an individual comes to see himself or herself as an engineer. However, this study goes further in that it examines a minority student population that has historically had a lack of representation in engineering in an academic context that has also frequently been overlooked, MSIs. In addition, this study goes beyond the previous literature in focusing on how attendance at MSIs influences the development of an engineering identity for minority students, which may not only predict retention for Black and Hispanic students, but also their future careers in an engineering discipline.

## **Methodology**

The data from this study were collected during the first year of a three-year longitudinal NSF-funded study. The research methods are described below.

### *Participants/Institution Profiles*

Data were collected from two HBCUs and two HSIs in the United States. HBCU1 ranks nationally among the highest producers of African-American undergraduates with science and

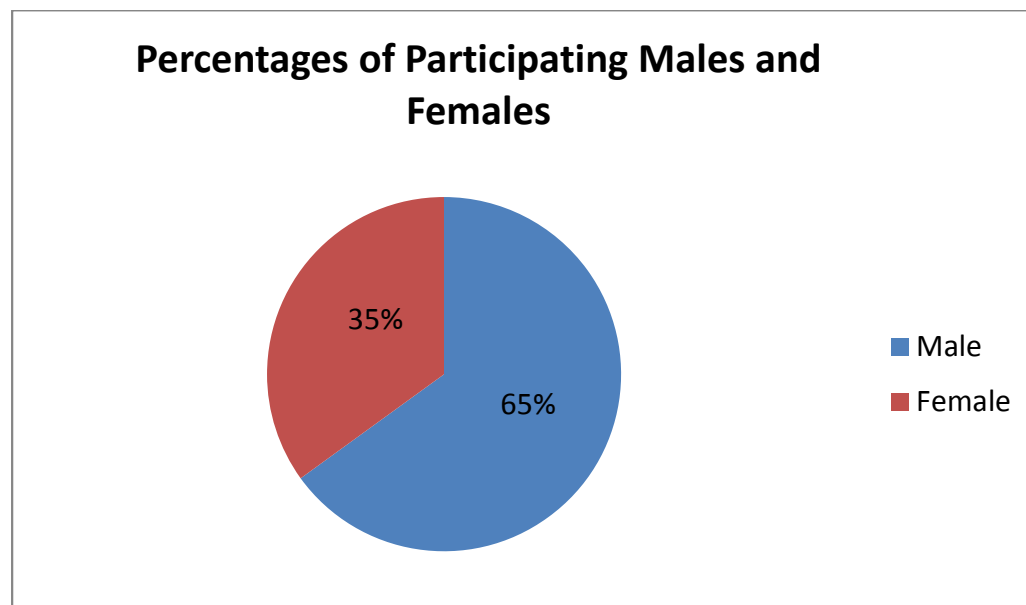
engineering degrees who go on to earn doctoral degrees (NSF, 2008). HBCU2, a public, urban institution, is the top producer of African-American undergraduates with engineering degrees as well as a top producer of female engineers. HSI1 is among the top producers of Hispanic engineers in the United States at all levels. HSI2 is a large public university recognized for the quality of its engineering program. All of the engineering programs at these institutions are ABET accredited. The demographics of each university can be seen in Table 1 below.

**Table 1.** *University Demographics*

	HBCU1	HBCU2	HSI1	HSI2
<b>Engineering Undergraduate Enrollment</b>	659	1344	3424	4694
<b>% of Minority Enrollment</b>	90	70	56	90
<b>Type of Institution</b>	HBCU, Private, Urban	HBCU, Public, Urban	HSI, Public, Urban	HSI, Public, Urban

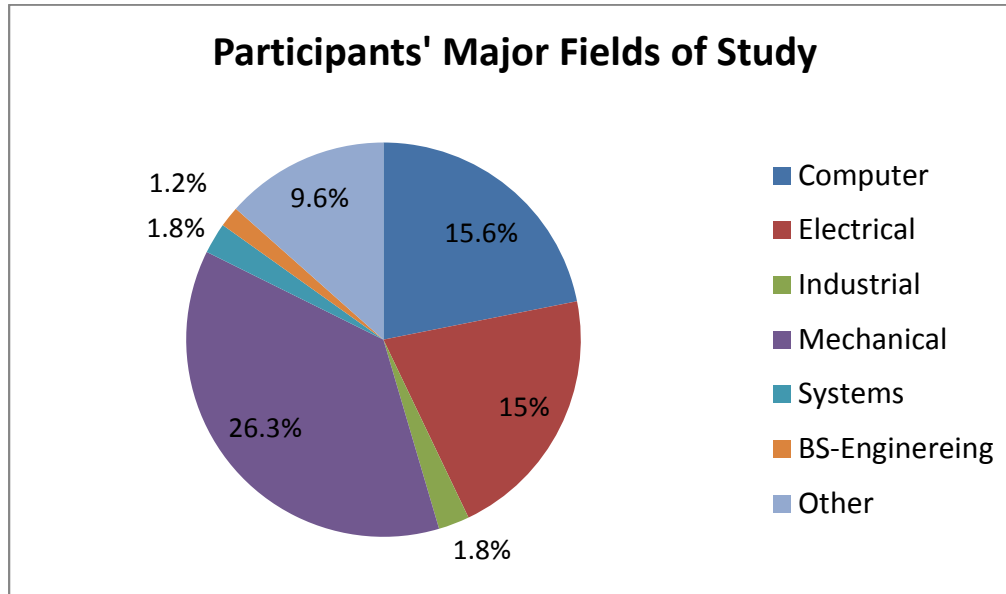
Ninety-four (94) Black engineering sophomores and one hundred eight (108) Hispanic engineering sophomores were selected to participate in the study using convenience sampling. The participants were recruited using email invitations, promotional materials posted in the engineering departments, as well as informational sessions. Male and female students from each major offered on each campus were included.

**Figure 1.** Percentages of Participating Males and Females



Of the 172 students who participated in the study, all students completed an online survey, while 76 participated in semi-structured interviews. The gender distribution and participants' major fields of study are shown in Figure 1 and Figure 2, respectively.

**Figure 2.** Participants' Major Fields of Study



### *Instruments*

The study used a mixed methods approach to collect qualitative and quantitative data. Once data were collected and disaggregated, we examined the variance in the educational experiences of students by race or ethnicity and type of institution (i.e., HBCU or HSI).

**Surveys.** Two survey instruments were used to collect quantitative data. The first survey, the Integration Survey, probed the extent of social and academic integration of the participants in their engineering programs, based on Tinto's theory of retention. The second survey, the Engineering Fields Questionnaire was constructed and validated as described in Lent, et al.<sup>33</sup> to probe students' self-efficacy, outcome expectations, and distal and proximal contextual influences. Participants' demographic data was also collected.

**Semi-structured interviews.** The one-on-one semi-structured interview design was a standardized list of questions that allowed for additional probing when deemed necessary. The semi-structured interviews were aligned with the survey and allowed for the collection of specific information related to engineering education, particularly identity development. The researchers were conscious of the participants' perspective and oftentimes adjusted the verbiage of the structured questions and used unscheduled probes<sup>34</sup>. These probes provided interviewers with a way to draw out more complete stories from the participants.

### *Data Analysis*

**Quantitative Data.** Part V of the Engineering Field Questionnaire included questions regarding participants' commitment to becoming engineers and was used to quantitatively measure participants' engineering identity. An exploratory factor analysis was used to determine the underlying constructs measured by the Integration instrument. The structure of these factors was examined to ascertain their levels of consistency with the constructs that were expected from the

theoretical base. Interactions with faculty and peers and intellectual development emerged as factors, which would be expected from Tinto's model of social integration. Participants responded to several statements regarding their engineering identity, their interaction with their faculty and peers, and their intellectual development at their university. Students responded by choosing from a 5-point Likert scale, ranging from *strongly agree* to *strongly disagree*, with an "*undecided*" option. Responses to statements on interactions with faculty and peers and intellectual development were from a 4-point Likert scale, ranging from *strongly agree* to *strongly disagree*. The statements comprising the factors can be found in Table 2 below.

**Table 2.** Survey Factors and Statements

Survey Factors and Statements	
Factor	Survey Statement
Engineering Identity	<i>I intend to major in an engineering field.</i>
	<i>I plan to remain enrolled in an engineering major over the next semester.</i>
	<i>I think that earning a bachelor's degree in engineering is a realistic goal for me.</i>
	<i>I am fully committed to getting my college degree in engineering.</i>
Interactions with Faculty and Peers	<i>Since coming to the College of Engineering I have developed close personal relationships with other students.</i>
	<i>The student friendships I have developed at the College of Engineering have been personally satisfying.</i>
	<i>My interpersonal relationships with other engineering students have positively influenced my personal growth, attitudes, and values.</i>
	<i>My interpersonal relationships with other engineering students have positively influenced my intellectual growth and interest in ideas.</i>
	<i>It has been difficult for me to meet and make friends with other engineering students.</i>
	<i>My non-classroom interactions with engineering faculty have positively influenced my personal growth, values, and attitudes.</i>
	<i>My non-classroom interactions with engineering faculty have positively influenced my intellectual growth and interest in ideas.</i>
	<i>My non-classroom interactions with engineering faculty have had a positive influence on my career goals and aspirations.</i>
	<i>Since joining the College of Engineering at this university, I have developed a close personal relationship with at least one engineering faculty member.</i>
Intellectual Development	<i>I am not sure if I will continue my studies as an engineering major.</i>
	<i>My interest in ideas and intellectual matters has increased since enrolling in the College of Engineering at this university.</i>
	<i>It is important for me to graduate from college.</i>
	<i>I am confident I made the right decision in choosing this university.</i>
	<i>It is likely I will register at this university next fall.</i>
	<i>It is not important to me to graduate from this university.</i>
	<i>Getting good grades is not important to me.</i>

**Qualitative Data.** Open coding was conducted in multiple rounds by two researchers. Coding involved interpreting participants' responses and assigning these responses to categories. Inter-rater reliability was achieved by the researchers coding five interviews together, agreeing upon



each code, then meeting after intervals of coding ten interviews each to discuss the coding that had taken place. This ensured that each researcher understood the interpretation of each code in the same way. The coding list evolved to thematic descriptors for the claims being made by the researchers.

## Results

### *Quantitative Data*

The means, standard deviations, and ranges can be found for Engineering Identity, Interactions with Faculty and Peers and Intellectual Development in Table 3. This data demonstrates that the average scores of students from each campus were above the median in each area. These scores suggest that students had an engineering identity, had positive interactions with faculty and peers, and felt as though their attendance at their MSI lead to their own intellectual development.

**Table 3.** *Means, Standard Deviations and Ranges of Interactions with Faculty and Peers, Intellectual Development and Engineering Identity*

	University	Mean	Standard Deviation	Range
<b>Engineering Identity</b>	HBCU1	18.93	2.049	4-20
	HBCU2	19.22	1.309	
	HSI1	19.02	2.232	
	HSI2	18.75	2.607	
<b>Interaction with Faculty and Peers</b>	HBCU1	31.57	4.113	10-40
	HBCU2	31.5	4.19	
	HSI1	29.05	6.06	
	HSI2	32.33	3.872	
<b>Intellectual Development</b>	HBCU1	20.67	2.291	6-24
	HBCU2	21.28	2.421	
	HSI1	20.75	2.326	
	HSI2	22.08	2.092	

There were statistically significant correlations found between participants' engineering identity and interaction with faculty and peers and intellectual development, which can be found in Table 4 below. Table 4 demonstrates that there was a significant positive correlation for both interaction with faculty and peers and intellectual development. This means that as interaction between faculty and peers increased, engineering identity also increased,  $r(208) = .457, p = .01$ . The same was found for intellectual development; as intellectual development increased, engineering identity increased,  $r(208) = .241, p = .01$ . These findings demonstrate a relationship between interaction with faculty and peers, intellectual development and engineering identity, but, unfortunately, it cannot be determined that increased interaction with faculty and peers and increased intellectual development *caused* an increase in engineering identity.

**Table 4. Correlations between Factors 1 and 4 and Engineering Fields Questionnaire Part 5**

	1	2	3
1. Engineering ID	--	--	--
2. Interactions	.457**	--	--
3. Intellectual	.241**	.316**	--

\*\* . Correlation is significant at the 0.01 level (2-tailed).

### *Qualitative Data*

Overarching themes that emerged from the data include *Engineering Identity: Engineering Student = Engineer; Challenge is Inherent; Caring Professors and Peers Strengthen Identity; The Relevance of Culture: Differences between Black and Hispanic Students Attending MSIs.*

**Engineering Identity: Engineering Student = Engineer.** Even in their second year, students were able to demonstrate that they had taken on some form of an engineering identity in several ways. When specifically asked whether or not being an engineering student was important to how they felt about themselves, participants overwhelmingly answered that it was “very important”, 51 out of 76 participants. Only a total of eight students responded with “not very important” or “not important at all.” When asked if they possessed skills that engineers must have, every participant named at least one skill they believe they shared with engineers and felt as though they were in the process of gaining other skills they felt engineers should have. After saying that mathematics and science skills were important for an engineer to have, Marques from HSI1 reported, “...I was really good at math when I was younger, but now it seems [to be] getting harder... I’m really good with science, though. Science is...one of my strong points.” Phylicia from HBCU1 mentioned teamwork, problem solving and creativity, then went on to say, “[I am] pretty good at teamwork, I’m working on problem solving, and ... I think I’m pretty creative.” Finally, Nathan from HBCU2 focused on the quality of being hardworking:

...I’m definitely hard working...I think I’m hard working and I’m persistent... I don’t like to quit. I feel like...I’m not a talker, so... if somebody feels like I’m going to do it wrong, I don’t want to tell them that I’m going to do it right. I just want to show them I’m going to do it right, or that I can do it right eventually...

Notably, students were asked the question, “In general, how do you feel about engineers?” and several answered labeling themselves as engineers, for instance, Seth from HBCU2 said [emphasis added], “I feel like *we’re* all trying... [to] reach the same goal. ... [W]*e’re* all trying to...put the hard work in and make a change. ... it’s very important for me to network with *my fellow* engineers because...you never know [if]...you might end up working with that person one day in the corporate world.” Florencia from HSI1 also said [emphasis added], “I think *we’re* great. I think *we’re* ...smart people. ... [W]*e’re* able to learn anything that you put in *our* way. ... [W]*e’re* ingenious. *We* come up with things.” Clifton from HBCU1 goes on to report [emphasis added], “I feel like *we* make the world go round.” And finally, Katrina explained:

I think engineers are the most [hardworking] students on campus, not just [HBCU1]. We

study the most. We try the hardest. But I do think that takes away from engineers being well-rounded as [people], which isn't a good thing. I think an engineer needs to be more well-rounded, less reclusive, and dabble [in] other things... [not just] engineering.

**Challenge is Inherent.** Participants were not specifically asked if they felt their major was a challenge; however, many participants' commented on the challenge of an engineering major in several ways, but in general they made it clear that the challenges they faced in majoring in engineering shaped their identity and how they saw others. Ava from HSI1 reported that, "... [B]ut every time I meet an engineer, they're very passionate about challenges. The more challenging a question, the better; like the more that they can think like out of the box, the better." Michael from HBCU1 even faced some doubt, "...I thought about changing my major several times. I probably think about changing my major every other week because it is hard and...it's just hard. It's difficult, you know." Daniel from HBCU2 did not share Michael's doubt, he stated:

I feel like I wanted to be an engineer because, on top of being one of the most highly paid professions so far in today's society, I feel like it offered me a chance to challenge myself. I'm not saying other majors are less challenging, but I feel like many of the skills I've acquired so far can be used...such as the sciences and the mathematical skills, and I just feel like it won't be a waste of those skills because those skills can constantly be applied being an engineering major.

Many participants also specifically commented on the difficulty of their coursework. For some, this difficulty negatively impacted their engineering identity and made them question their choice of majoring in engineering; however, there were students who felt they were ready to meet the challenge, which strengthened their engineering identity. Everett from HBCU1 was ready:

The classes you go through are brutal...They build you up for something...What I understand is if you can survive those classes and come out strong, you can survive anything out there and come out strong...And, that's why this is very important to me, coming out very, very strong. Not just coming out with a degree --coming out very, very strong in my degree.

The difficulty did not stifle Marissa from HSI2 who said, "... No, [my experiences at this university are] positive... [T]he class[es] are hard but it's... good, it's positive. The...professors ... are gentle and impressive ...."

Students also noted that although they generally found their engineering professors to be pleasant, these professors were challenging, which motivated them to complete their engineering degree and therefore strengthened their engineering identity, from Jorge from HSI1, "They're tough...Tough. ... [T]hey're nice... [B]ut...they make you work for it...Which is good...I like challenge..." Nicole from HBCU1 explained her experience in more detail:

... [H]ere, it's like, no, you're on your own...I haven't really had any negative experiences. ... [W]ith, with the research project [I did with a professor], [the professor

should have] just put in more...input instead of having me do every single thing because...I've never done a research project before... [T]hat's the only...challenging aspect with working with the faculty - them expecting me to ... put more effort in[to my work] on top of staying through all the classes and...doing everything and balancing everything.

Participants gave further evidence that the challenge of majoring in engineering galvanized students to take measures to succeed in their engineering major, Mattias from HSI1 said, "I think it's...a really hard major... but it's actually what I wanna do...I don't wanna give up. Actually, I want to finish everything up..."

**Caring Professors and Peers Strengthen Identity.** The quantitative data reveals that participants had both positive relationships with their professors and peers and that this was positively correlated with the development of their engineering identity. Several participants commented on how caring they felt their professors were. However, there were participants who had negative experiences with their professors, feeling, for instance, that professors were more concerned with their research than teaching, not available enough to answer questions, or not able to convey their lessons well. Participants' statements demonstrate that these individuals played a role in motivating them to continue in their major and to work hard to become engineers – showing a positive impact on engineering identity. Mitchell from HBCU1 said of his professors, "But [in the] engineering [department] you get...half and half. Half of [the professors] will [not teach well], [the] other half are pure geniuses who actually genuinely care about you." While, Georgia from HBCU2 had a slightly more positive experience:

...I came over [to this university before I enrolled], and I...was just browsing...I spoke with an advisor in the industrial engineering program, Ms. V. ... [S]he was just so nice. She was caring. As soon as I came in, she [said], 'Oh, we need you here. We need people here.' And I [said], "Okay, okay." I was at [another university] at the time, and I just felt like a number there. But as soon as I came here...they just automatically showed me that they cared.

Georgia's experience was similar to that of Carlos from HSI1 and Ricardo from HSI2. Carlos said:

...I have my classes with [the engineering faculty] and they're really nice and they're very knowledgeable. They know what they're doing... I think it was Dr. S for engineering ethics...he would go through and explain everything, and then he would use his background...in transportation...for the Department of Transportation. He uses his background in that and... connect[s] everything else...He's really good. The faculty is great here.

Ricardo also reported:

...[T]hey're all really good...[T]hey have been really, really good [people]...[W]hen I have... any doubts...I easily can go to ... the director to engineering, and she...looks

happy ... to interact with me or...to help me. [A]nd ...when she feels that I ... get ... relief and ... you can see her... happiness... 'I helped him,' ... And that's a good feeling for me.

Participants' engineering identity was also influenced by their peers. Participants reported having friends on campus; however, in some cases, participants felt as if they were in competition with their peers or did not have a real connection with them. Conversely, several participants reported belonging to study groups with their peers and networking with their peers in various engineering student organizations, which allowed them to ask for and give peers help and advice regarding their coursework. Black students were more likely to report feeling as if they had a community or familial relationship with their peers. For instance, Belinda from HBCU1 explained:

I think the most helpful aspect [of student engineering organizations] is the fact that... people are willing to help you if you need help with anything...[T]he whole thing is a little bitty family and there are always people who've been where you were before and know exactly what you're going through. So there's always...advice to be given if you need help with homework or tests, different things like that.

Benjamin from HSI1 tells of an experience that helped shape him as an engineering student:

...[T]he guys took me out to the machine shop a couple of nights....out of the semester and...they taught me how to use a lot of the machines. The drill press, how to tap in... create threads for holes and things like that. And that was a really great experience. That wasn't anything that was pre-organized or anything. That was just me [asking], 'Hey, do you guys need help?'

Javier from HSI2 spoke of his peers as saviors:

Well, the first year, I was pretty lost. Luckily, I found [student engineering organizations] pretty quickly and I became friends with most of the directors, so I used to hang out there a lot. I learned a lot of things... [T]hey [even] helped me with my résumé for the first year. And it ...was very helpful during the time. I didn't feel as lost as most new students. They would [be there] if I needed help with anything college related....

Finally, Alexander from HBCU2 spoke of the importance of making a good impression on his peers:

Um, when you studying with ... with your peers and, like, you're interacting with them, it's important for them to know that you're a hard worker, because hard workers kind of -- they kind of try to stay around each other, you know. They try to be successful. Successful people try to stay around successful people...So my peers know that I'm serious.

**The Relevance of Culture: Differences between Black and Hispanic Students Attending MSIs.** Finally, regarding students' thoughts on attending an MSI, Black students specifically mentioned the importance of attending an HBCU. There is no evidence that the Hispanic American participants were aware that their university was a Hispanic Serving Institution, however, Black students reported choosing their university because it was an HBCU, at least in part. Rashida from HBCU2 reported, "I wanted to go to an HBCU, [and this university] had a good engineering program." Darren from HBCU2 elaborated:

I know why I go to an HBCU. The school is very diverse. It's culture. It [is] "people" diverse. Not just in color, but their culture and [where] they come from. Not what just they're born with. Some people are born Hispanic, Asian, White, all that. No, that's not... [the only kind of] diversity...I thought that was. Then I came [to this university] and learned that it doesn't matter what box you check. [We've] got these people from the [District of Columbia, Maryland, and Virginia area], these two from this area code, who talk so much differently from you but they're black.

Samantha realized her desire to attend an HBCU after visiting HBCU1:

[This university] was the only HBCU that I applied to...I didn't really think about going [to this university until]...I came to visit and it...seemed very...stimulating...[W]hen I walked around, people were having intellectual conversations...People were talking about society, they were talking about things that they wanted to do. And when I came to visit the Engineering Department...they just talked about how Microsoft had repeatedly hired the most interns from [this university] and the kind of things that...students were doing and getting into those graduate schools at the PWIs. So I knew that coming to [this university] could be a good place for me ...I decided to come here [to] get some more background about my heritage, since we have to take...African American [Studies] classes, but then somewhere where I could grow and be able to go on and do the great things that people who go to PWIs do also.

Finally, Jeremiah from HBCU1, specifically desired to attend an HBCU:

... [HBCU1] was a historically black college, and I was looking to go...to a historically black college. And also, it was...one of the top...coed...HBCU[s], so that intrigued me. ...[C]oming into college, I initially didn't know what I want to major in...I just knew I wanted the school to be...good in academics overall and... [an] HBCU.

## **Discussion**

The engineering field in the United States is suffering from lower enrollment in academic institutions across race, ethnicity and gender; and yet as the engineering workforce globalizes, it becomes more and more important that the United States not lose its foothold in the engineering disciplines and that those in engineering represent a diversity of race, ethnicity and gender. This being the case, the study of minority students in engineering is much needed, especially at Minority Serving Institutions, as those institutions have been shown to have higher rates of matriculation and graduation of minority students. In order to understand what factors lead minority engineering undergraduate students to obtain their degree in engineering, this study

examined engineering identity, because it is likely that when students develop an engineering identity, in other words, feel as though engineering has become a part of them, they are more likely to complete their engineering degrees and become engineers.

The findings of this study addressed the research question: “How do underrepresented minority students come to identify themselves as engineers?” Participants demonstrated that they had some degree of an engineering identity as a second year student in both the quantitative and qualitative data collected. In addition to this, participants cited several factors that either strengthened or weakened their engineering identity. In regards to strengthening their engineering identity, several students spoke of challenges, interactions with faculty or peers that increased their belief that they would become engineers. Conversely, participants also mentioned experiences that led them to believe they should change their majors and pursue careers other than engineering. The findings also supported Tinto’s model of integration, as well as engineering identity theory. This study demonstrated that the Black and Hispanic engineering undergraduate students attending MSIs who participated in this study had cultural identities as well as cultural commitment, two of the pre-enrollment characteristics that have been found to predict retention for minority students in STEM programs. Students’ reports established that their engineering identities correlated with the challenging coursework they faced at MSIs, the relationships they developed with their professors and peers, as well as their intellectual development at MSIs. The correlations found were further supported by interview responses.

As can be seen in the findings, participants finding the coursework challenging pushed them harder to do their best to become engineers, which also increased their self-efficacy in their knowledge of engineering. Their relationships with their professors and peers helped to manage the challenge through learning, networking, studying, and tutoring; however, these relationships also gave them encouragement that they had the ability to complete their degrees, assurance that they were not going through a difficult time alone, and guidance to help them make the right choices toward completing their degrees. In addition to this, it is also notable that Black students were more likely to mention the fact that their university was an MSI in general than Hispanic students. As shown above, Black students mentioned in general or acknowledged that their university was a historically Black university, but Hispanic students never mentioned that their university was a Hispanic Serving University, bringing into question whether or not they knew the status of their university as a HSI. Even without this knowledge, it is clear that Hispanic and Black students alike benefited from attending their university in that in the majority of cases, these students’ engineering identities were strengthened by their various experiences at these universities.

The findings also give support to the engineering identity model. Students remarked on their understanding of engineering as a science when speaking about their coursework as a challenge they felt they were able to overcome. This was also true regarding the skills they felt they were developing as a result of their engineering programs. Students also spoke at length about the environment, composed of their peers and professors, of their institutions and how this influenced their engineering identity development.

A limitation of this study was that causality could not be found between the development of an engineering identity and the factors of challenging coursework, relationships with professors and

peers and the overall quality of the engineering program and university. Future research should seek to find a causal relationship between engineering identity and these factors.

## Conclusion

The results of this study demonstrate that Black and Hispanic undergraduate engineering students not only have engineering identities, but that these identities are shaped by their experiences at Minority Serving Institutions. What was notable in this study was how caring students found both their faculty and peers to be in their engineering programs. Past studies have found that minority students found the atmosphere of PWIs hostile and competitive, while students at MSIs reported the opposite for the most part, which is especially surprising for successful engineering programs. While engineering programs seem to be overwhelmingly characterized by their competitiveness, the engineering programs at the MSIs that participated in this study had excellent reputations, documented success in graduating minority students, *and* provided family-like environments where the students felt welcomed and cared for. Yet students also reported receiving challenging coursework from professors that demanded they work hard to earn their degrees. In short, these institutions provided the academic substance and support to help students see themselves as successful engineering students and therefore successful engineers, elements that many minority students do not find at PWIs.

## References

1. Banta, T. (Ed.) (1993). *Making a difference: Outcomes of a decade of assessment in higher education*. San Francisco: Jossey-Bass.
2. Seymour, E. and Hewitt, N. (1997). *Talking About Leaving: Why Undergraduates Leave the Sciences*. Boulder, CO: Westview Press.
3. Turner J. C. (1985). Self-categorization. In J. C. Turner, M. A. Hogg, P. J. Oakes, S. D. Reicher, & M. S. Wetherell (Eds.), *Rediscovering the social group* (pp. 42-67). Oxford, UK: Blackwell.
4. Russell, M. L., & Atwater, M. M. (2005). Traveling the road to success: A discourse on persistence throughout the science pipeline with African American students at a predominantly white institution. *Journal of Research in Science Teaching*, 42(6), 691-715.
5. Moore, J. L., Madison-Colmore, O., & Smith, D. M. (2003). The prove-them-wrong syndrome: Voices from unheard African-American males in engineering disciplines. *The Journal of Men's Studies*, 12(1), 61-73.
6. Kim, M. M. (2002). Historically Black vs. White institutions: Academic development among Black students. *The Review of Higher Education*, 25(4), 385-407.
7. Li, X., & Carroll, C. D. (2007). Characteristics of Minority-Serving Institutions and Minority Undergraduates Enrolled in These Institutions: Postsecondary Education Descriptive Analysis Report (NCES 2008-156). *National Center for Education Statistics*.
8. Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.). Chicago: University of Chicago Press.
9. Taylor, E. and S.G. Olswang. (1997). Crossing the color line: Blacks and predominantly White universities. *College Student Journal*, 31, 11-18.



10. Besterfield-Sacre, M., Altman, C. J., & Shuman, L. J. (1997). Characteristics of freshman engineering students: Models for determining student attrition in engineering. *Journal of Engineering Education*, 86, 139-149.
11. Roach, R. (2004). Losing ground. *Black Issues in Higher Education*, 2(2), 28-29.
12. Bonous-Hammarth, M. (2000). Pathways to success: Affirming opportunities for science, mathematics, and engineering majors. *Journal of Negro Education*, 69, 92-111.
13. Huang, G., Taddese, N., & Walter, E. (2000). *Entry and persistence of women and minorities in college science and engineering education*. (NCSE Rep. 2000-601). Washington, DC: U.S. Government Printing Office.
14. Simpson, J. C. (2000). Segregated by subject: Racial differences in the factors influencing major between European Americans, Asian Americans, and African, Hispanic, and Native Americans. *The Journal of Higher Education*, 72, 63-100.
15. Leuwerke, W. C., Robbins, S., Sawyer, R., & Hovland, M. (2004). Predicting engineering major status from Mathematics achievement and interest congruence. *Journal of Career Assessment*, 12, 135-149.
16. Braxton, J. M., Sullivan, A. S., & Johnson, R. M. (1997). Appraising Tinto's theory of college student departure. In J. C. Smart (Ed.), *Higher education: A handbook for theory and research*, 12 (pp. 107-164). New York: Agathon.
17. Wenglinsky, H. H. (1996). The educational justification of historically Black colleges and universities: A policy response to the US Supreme Court. *Educational Evaluation and Policy Analysis*, 18(1), 91-103.
18. Wolf-Wendel, L. (1998). Models of excellence: The baccalaureate origins of successful European American women, Black women, and Latinas. *Journal of Higher Education*, 69, 141-86.
19. Allen, W. R. (1992). The color of success: African-American college student outcomes at predominantly White and historically Black public colleges and universities. *Harvard Educational Review*, 62(1), 26-45.
20. Li, X., & Carroll, C. D. (2007). Characteristics of Minority-Serving Institutions and Minority Undergraduates Enrolled in These Institutions: Postsecondary Education Descriptive Analysis Report (NCES 2008-156). *National Center for Education Statistics*
21. Munoz, D. G. (1986). Identifying areas of stress for Chicano undergraduates. *Latino college students*, 131-156.
22. Fiske, E. B. (1988). The undergraduate Hispanic experience: A case of juggling two cultures. *Change: The Magazine of Higher Learning*, 20(3), 29-33.
23. Gee, J.P. (1999). *An introduction to discourse analysis: Theory and method*. New York: Routledge.
24. Gee, J.P. (2000–1). Identity as an analytic lens for research in education. *Review of Research in Education*, 25, 99–125.
25. Buxton, C.A., Carlone, H.B., & Carlone, D. (2005). Boundary spanners as bridges of student and school discourses in an urban science and math high school. *School Science and Mathematics*, 105, 302–312.
26. Carlone, H. B. & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science and Teaching*. 44, 1187-1218.
27. Holland, D., Lachiotte, W., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds*. Cambridge, MA: Harvard University Press.

28. Pawley, A. L. (2008). Work in progress: Engineering identity markers in faculty members. In *Research in Engineering Education Symposium*. Davos, Switzerland.
29. Stonyer, H. (2002). Making engineering students -- making women: The discursive context of engineering education. *International Journal of Engineering Education*, 18(4), 392-399.
30. Oldenziel, R. (1999). *Making technology masculine: Men, women, and modern machines in America, 1870-1945*. Amsterdam: Amsterdam University Press.
31. Frehill, L. M. (2004). The gendered construction of the engineering profession in the United States, 1893-1920. *Men and Masculinities*, 6(4), 383-403.
32. Bix, A. S. (2004). From 'engineeresses' to 'girl engineers' to 'good engineers': A history of women's U.S. Engineering education. *NWSA Journal*, 16(1), 27-49.
33. Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, 45, 79-122.
34. Berg, B. (2007). *Qualitative research methods for the social sciences*. (6th ed.). Boston: Allyn and Bacon.