

ORIGINAL ARTICLE

Resilient engineering identity development critical to prolonged engagement of Black women in engineering

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Abstract

Background: Social identity theory has been used to understand student and professional engagement in engineering. Engineering identity development, however, can be disrupted by the barriers and challenges associated with the racialized and gendered perceptions of engineering.

Purpose/Hypothesis: This study examined the engineering identity development and resilience of Black women engineers in industry through the exploration of their experiences in the engineering workplace. Many studies document challenges that underrepresented groups face in engineering. This work, instead, focuses on particular supports and empowerment that enabled continued participation in the engineering workforce over time.

Design/Method: This interpretative phenomenological analysis consisted of nine self-identified Black women engineers currently employed in engineering industry with at least 10 years of work experience and explored the background, pathway into and through engineering, and what it means to be an engineer through 90-min interviews with each participant.

Results: The results of this study suggest that engineering identity development alone does not contribute to the retention of Black women in the engineering workplace but instead the confluence of race, gender, and role identity that aids in developing a resilient engineering identity.

Conclusions: The formal, informal, and structural educational experiences of Black women engineers are critical to the development of a resilient engineering identity. This identity is dependent on the complexities associated with being Black, a woman, and an engineer.

KEY WORDS

diversity concerns, engineering profession, identity, race/ethnicity, retention

1 | INTRODUCTION

The United States has set forth an agenda with ambitious but achievable goals to address national and global problems known as the Grand Challenges for Engineering (National Academy of Engineering, 2019). The ability to accomplish

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these Grand Challenges, however, is threatened by a shortage of engineers. The occupational supply and demand have spawned national initiatives to broaden participation to all Americans, including women and minorities, into high-paid, highly rewarding fields (White House, 2013). Scholars have long noted that engineers with different ethnic, gender, and cultural backgrounds bring a variety of life experiences to the workplace that, if wisely managed, can encourage creative approaches to problem solving and design, dismantle the common mindsets associated with mainstream society, and challenge social structures that are reinforced by limited participation (National Academy of Engineering, 2002, 2004; Riley, 2008).

Given the necessity to broaden participation, scholars have explored the many factors that engage and retain diverse populations to and through the field of engineering (Chubin et al., 2005; May & Chubin, 2003). One such factor is engineering identity development (Godwin et al., 2016; Huff, 2014; Huff et al., 2018; Perez et al., 2014; Pierrakos et al., 2009; Ross & Godwin, 2016; Tonso, 2006). Identity scholars have reported that in the fields of STEM, role identity development is critical to engagement and persistence; however, it is often jeopardized by structural influences and competing identities (Johnson et al., 2011; Ong, 2005; Ross & Godwin, 2015). Underrepresented populations, especially those at the intersections of multiple underrepresented identities like Black women, have to navigate systems that have been historically White and male as well as grapple with the congruence or incongruence of their identities as a Black person, a woman and that of being an engineer. Some women have been able to successfully navigate this identity trajectory; however, the role of particular structures and the agency of these women to reshape their environments has not been a focus in the literature. This study presents how Black women engineers, who have multiple identities, were supported in or overcame barriers in their engineering pathways by presenting the experiences of nine Black women engineers who have persisted in engineering for 10 years or more.

2 | BACKGROUND

Currently, Black women comprise 6.4% of the U.S. population and only 0.72% of engineering industry employees (U.S. Census Bureau, 2014; Falkenheim & Burrelli, 2012; National Science Foundation, 2015; Yoder, 2014). In many cases, their small numbers have rendered them insignificant in quantitative studies, and, thus, this population has been largely overlooked in the conversation around broadening participation and prolonged engagement in engineering beyond an undergraduate degree. One exception to the lack of research on professional Black STEM women is the work by identity scholars, especially in science education. A focus on understanding Black women's experiences in the workforce began when science education researchers explored the impact race, gender, and role identity (i.e., science identity) had on persistence and engagement (Carlone & Johnson, 2007; Ceglie, 2011; DeCuir-Gunby et al., 2013; Johnson et al., 2011; Ko et al., 2014; Obiomon et al., 2007; Ong, 2005). Engineering education has seen a growth in the exploration of engineering identity research in K-12, undergraduate, and industry areas (Capobianco et al., 2011; Godwin et al., 2013; Ross, 2016). Despite this growth in literature around identity and engineering engagement, there remains a gap in systematic research that explores identity among Black women in engineering industry. The literature that does exist often represents Black women's experiences and the emerging phenomena anecdotally. This study contributes to filling this gap by providing insight into the experiences of Black women in engineering that aid in the development of their engineering identity; the complexities associated with the intersections of race, gender, and role; and the resultant resilient engineering identity development. This study was guided by the following research questions:

1. How do Black women in engineering industry develop their identities?
2. How do Black women in engineering industry experience their individual identities?
3. How do Black women navigate the structure-agency dialectic in developing resilient identities to remain in engineering fields for 10 years or more?

3 | LITERATURE REVIEW

The formal archival literature on Black women in engineering industry is limited; therefore, this literature review examines closely the few studies on Black women in engineering industry as well as introduces the production of literature from less formal settings (such as professional organization publications). Results from a systematic literature

search were categorized as women in engineering industry or Black women in the workplace (nonengineering). When the search terms were narrowed to focus on the topic of Black women in engineering, only six results emerged: five publications and one dissertation. However, when the search was expanded to include nonscholarly works or popular culture, the literature on Black women in engineering industry increases, with four articles from magazines centered on Black women's issues. To lay the groundwork for this literature review, both forms of literature are discussed.

There are three main studies encompassed in the scholarly works around Black women. First, Bell in 1990 situated her study on career-oriented Black women around the concept of biculturalism. Her study focused on Black professional women more broadly, but one participant was an engineer. In this work, biculturalism was defined as the perception that an individual is living in two distinct cultural contexts. Often, in the case of Black women, one culture (personal) is Black, consisting of her family and community, while the other culture (professional) is White, established and dictated by the dominant American culture. Bell argued that the key to a bicultural existence is compartmentalization (Bell, 1990). Unlike assimilation, in which a Black woman is expected to abandon her Black cultural identity, compartmentalization allows a woman to maintain her Black cultural identity. Compartmentalization may reduce the chance of two cultural contexts colliding; it also creates greater separation between work life and home life. The idea of biculturalism also highlights a potential tension in Black women's multiple identities.

The second study was conducted by Rice (2011) using an ecological model of career development as a theoretical framework to examine Black women in engineering industry and provided insight into the barriers and supports that influenced career attainment as well as experiences in the workplace. The barriers identified included the lack of diversity in the workplace and the challenges associated with age, race, and gender (collectively). Lack of diversity made participants hypersensitive to their identity as Black women engineers. This heightened awareness was accompanied by a feeling of pressure to perform better, faster, and with fewer flaws than their White male peers. Lack of diversity in the leadership of their places of employment also provided a visual reminder of limited upward mobility (Rice, 2011). All of the women spoke of the workplace being "unreceptive, hostile, and/or challenging," and they often felt alone (Rice, 2011, p. 153). Rice also identified structures of support that included microsystem support (e.g., self-image, determination, and perseverance) and macrosystem support (e.g., family, friends, minority networks, mentors in the workplace, managerial support, and company structure). Despite the barriers and challenges, the participants persevered and continue to strive in engineering due to what the author described as determination and perseverance and the support of workplace affinity groups, mentors, family, and friends.

The third study, conducted by Ross and Godwin (2015, 2016), examined the experiences of Black women in engineering industry guided by social identity theory. Their study unearthed themes associated with gender dynamics and the perceived incongruence between what the participants described as the "textbook" definition of an engineering identity versus the participants' "personal" definition of an engineering identity. More importantly, this study presented the phenomena of women reauthoring their own personalized definition of engineering identity that "embodied their whole-selves" through their agency (Ross & Godwin, 2016, p. 5). This new convergent identity provided the power and confidence to push against the structures in the workplace that they perceived were not welcoming of their multiple identities as a Black, woman, and engineer.

In addition to these scholarly works, there is a growing body of literature in the professional organization sector, namely the American Association of University Women (AAUW). AAUW in the past 2 years has released three investigative pieces, along with a powerful blog, on the experiences of one Black woman's engineering career (DeOrnellas, 2015a, 2015b; Hughes, 2013; Joy, 2014). While these articles are not situated in educational theoretical frameworks or grounded in traditional methods of inquiry, they spotlight complex experiences associated with stereotype threat, isolation, "prove-it-again" (i.e., others are presumed to be competent, while these women have to repeatedly prove their competence), pay inequity, and what one described as a "loss of self."

The discussion on Black women in engineering industry in scholarly work has been sparse in the last two decades. In contrast, the conversation has begun among professional organizations in the past 2 years. The stories are being told primarily informally, but the message is still clear—these women, although they share many experiences with White female culture, also have unique experiences of their own worth of the engineering education community's attention. The existing literature has introduced useful frameworks for explaining the experiences of these women; nonetheless, there is opportunity to build this literature by focusing on the role of identity on choices to engage or retreat from engineering. Prior work from identity scholars suggest that discipline identity salience is critical to occupational choice and persistence in engineering (Godwin et al., 2016; Meyers et al., 2012; Pierrakos et al., 2009; Tate & Linn, 2005). The results of this

study expand the understanding of the experiences of Black women in engineering while also contributing to the body of literature around the importance of engineering identity on the retention of Black women in engineering fields.

4 | THEORETICAL FRAMEWORK

For this research, two frameworks were used—social identity theory and intersectionality. Social identity theory is a theoretical framework that has been leveraged in the spaces of science education and engineering education to better understand engagement, persistence, and retention of students K-16 in STEM fields (Honey et al., 2014). Established scholars such as Hatmaker (2013) in engineering have extended this work to investigate the role of identity in prolonged engagement of women in the context of industry. The results of such work were the basis of a position paper by Ross et al. (2017) that suggested that social identity theory is an appropriate framework for understanding the factors that contribute to the pursuit and persistence of engineering as an occupation for Black women. As such, this study used social identity theory, more specifically the structure–agency dialectic and competing identities, to guide and interpret findings. These components of social identity theory are described in detail below.

Identities are socially constructed (Butler, 1990; Clarke, 2008; Omi & Winant, 1994) and are claimed by individuals as well as ascribed to individuals. Given the expansive research in identity theory, there are many definitions of identity; however, for the purposes of this research, identity theory is defined as being limited to social identity and role identity. In this paper social identity refers to the constructs of race/ethnicity and gender (Tajfel, 1981), and role identity refers to the parts or roles of a self constructed by meanings that a person attaches to the many roles they play in their world or role identity (e.g., science identity, engineering identity; Stryker & Burke, 2000). The research reported here largely focuses on social identity (at the intersection of race and gender) and role identity (as engineers). Identity is a complicated construct that is wrought with tension and in some cases, hierarchical complexities that make claiming, developing, and retaining an identity difficult. To frame the work, an explication of the structure–agency dialectic and competing identity hierarchy follows.

4.1 | Structure–agency dialectic

The structure–agency dialectic acknowledges the tension of an individual's autonomy (agency) versus the socialization (structure) in which they exist. Some identity theorists assert that individuals have agency or can determine who they are or want to be; however, other theorists argue that social structures can either impose constraints on that agency or provide opportunities that enable an individual to overcome such constraints (Burke & Stets, 2009). When an individual assumes an identity that is in line with social structures or social norms, this decision reinforces the social structure. Therefore, declaring autonomy is misleading, as the developed and claimed identity is congruent with dominant norms (Burke & Stets, 2009). Agency without context has an appearance of being independent and self-determined, and socialization without agency has the appearance of being an oppressive structure that renders an individual incapable of making a decision about their identity. Structure and agency act as forces that influence each other. In some instances, individuals can assert agency that changes structures, and likewise, structures can impose on an individual's agency. Giddens (1984) proposed that structure and agency constantly interact with each other with the introduction of structuration theory. He postulated that structure and agency are in concert with one another when he stated that it is “the repetition of the acts of individual agents which reproduces the structure” (as cited by Gauntlett, 2002, p. 93). Recognizing that structure and agency are forces that can influence and inform each other is important in the study of identity.

Tonso (1996) laid the groundwork for scholars when she noted the effects of the male-dominated nature of engineering and the structures associated with it that detracted from the identity salience of women in engineering. The impacts of culture, environment, and other structures on identity have been identified by many scholars (Bastalich et al., 2007; Carlone & Johnson, 2007). In contrast, Ko and fellow researchers (2014) explored agency when they investigated women of color's strategies for persistence and success in physics and astronomy. Prior literature exploring the structure–agency dialectic in science and engineering environments highlighted the complexity associated with ascribing an engineering identity to oneself while also contending with the structures inherit with deviating from the norms associated with engineering environments and cultures. For example, Black women who

have adopted an engineering identity may be prepared academically and engaged; however, there are structural forces that have been identified as pushing them out of engineering. Understanding Black women's ability to negotiate structures through specific agency strategies could aid in understanding mechanisms for increasing retention in engineering.

4.2 | Competing identities

In addition to battling structures, people are said to have as many selves or identities as they have groups of people with which they interact (Stryker & Burke, 2000). This multitude of identities is often organized in a salience hierarchy with some identities performing central roles in a person's social and self-determination and other identities being downplayed or even unacknowledged (Smith, 2007). Sometimes these multiple identities are in conflict with, or competing with, one another for saliency. Identity negotiation, or the act of reconciling competing identities, can be influenced by a variety of factors: the importance of social identities to a person, the setting in which one is located, and the actions and influence of other people in those settings (Deaux, 2001). For example, being the only woman in a group of men can make gender identity more salient. Specific situational cues can also disrupt the hierarchy; a comment by another person about one's age or ethnicity will make that identity more salient (Deaux, 2001). Environments have the ability to influence salience in a time-based sense as well. Most people have the autonomy to choose their environment; however, there are instances where circumstances create a less desirable environment. In cases such as these, for a person whose social category is to some degree stigmatized, threats to identity may be posed that require the development of strategies to cope with those threats. Sometimes this may mean negating the identity or temporarily diminishing its importance (Deaux, 2001). An example of such a coping mechanism is biculturalism, which assumes that it is possible for an individual to know and understand two different cultures. It also supposes that an individual can alter her or his behavior to fit a particular social context (LaFromboise et al., 1993). Black women may embody a strong engineering identity; however, this identity can be threatened in the White male-dominated engineering workplace.

This research examines how identity saliency and competition of multiple identities (e.g., being Black and a woman as social identities and being an engineer as a role identity) have an impact on Black women's retention in the engineering workplace. Examining both individual's agency as well as the context in which they work provides a fuller picture of how identity may shape and support lasting pathways through engineering industry.

4.3 | Intersectionality

Intersectionality is the recognition of a person who simultaneously has two or more social categories or social status (e.g., race, gender, class, sexual orientation) and the unique oppression that results from that combination. The idea of analyzing race, gender, and class identities together has existed for more than a century (Hancock, 2007a); however, the term "intersectionality" was only established approximately 30 years ago. Crenshaw (1989) introduced the term as a critique of the single-axis framework that was dominant in law. She found that Black women plaintiffs sometimes experienced discrimination in ways similar to White women's experiences, while other times they shared similar experiences with Black men. They also often experienced double discrimination—the combined effects of discrimination on the basis of race and on the basis of sex as Black women (Hancock, 2007b).

A narrow, single axis interpretation of experiences has been prevalent in research as well, until recently with a slow growing acknowledgment of the necessity to expand research to include groups that have been systematically underrepresented in research because they are not numerically significant (Litzler et al., 2014). Intersectional research gives deliberate attention to women within the margins of society and illuminates what is overlooked when a social category (i.e., women) is assumed to include only privileged subgroups (i.e., White women) of that category. An intersectional approach allows for the examination of the diverse experiences of women who possess multiple identities. Reflecting on who is included within a category can facilitate representation of those historically overlooked in an attempt to repair the misconceptions in existing literature (Cole, 2009). By focusing on groups that have been neglected, researchers are better able to arrive at a contextualized understanding of Black women's experiences rather than viewing them in terms of the way they depart from norms defined by dominant groups.

Intersectionality makes it clear that gender, race, class, and sexuality simultaneously affect perceptions, experiences, and opportunities of individuals who live in a society stratified along these identities. Incorporation of previously ignored and/or excluded populations into knowledge construction to broaden our knowledge base could facilitate more adequate solutions to traditional questions posed by our discipline (Hancock, 2007b). Intersectionality provides a means for answering contemporary questions that increasingly demonstrate the flaws of a race-only or gender-only approach to research.

5 | METHODS

We approached this investigation by using interpretative phenomenological analysis (IPA) as a methodological framework to guide our procedures for collecting and analyzing data. IPA is well-suited as a methodology for this investigation as it provided us a way to deeply probe the lived experiences of individual Black women engineers, enabling us to find resonance across the idiosyncratic participant accounts while also maintaining sensitivity to the individual cases (Smith, 2011; Smith et al., 2009).

IPA is a qualitative research approach that provides a methodological framework for investigations related to personal and lived experience, providing the research team an approach to illuminate features of embodied experience that might otherwise be overlooked. Moreover, the research method is characterized by an intentional approach of investigators to carefully acknowledge and integrate their theoretical and other presuppositions with the experience of participants. In this investigation, IPA provided a tool for deep listening, both in the data collection and analysis, of the complex interplay of identities as experienced by Black women engineers in industry. Similarly, IPA has been used in other engineering education studies to generate contextual knowledge claims on social identity (Jungert, 2013), motivation (Kirn & Benson, 2018), and identity development (Huff et al., 2018).

In the subsections that follow, we detail how we used IPA as a methodological framework for this investigation to guide our sampling procedures, interview strategies, and data analysis.

5.1 | Participant sampling

The participants in this study consisted of nine Black women currently employed in engineering industry with at least 10 years of experience in the workplace. The role of “engineer” was defined as women who had earned an engineering degree in their undergraduate education, who were working in an engineering environment, and who self-identified as engineers. Participants self-identified as both women and Black, which included any variation of the Black diaspora—African, African American, Caribbean American, mixed race, and so forth.

Consistent with the practices of IPA research, we solicited a homogeneous sample of participants (Cohen et al., 2011; Smith, 2011). A homogeneous sample is often described as consisting of participants with similar traits and/or as providing access to a particular perspective on a phenomenon under study (Smith et al., 2009). As such, homogeneity may be bound by factors such as access to a population, time, or rarity of the phenomenon (Smith et al., 2009). Homogeneity for this study is defined by the racial identity, gender identity, discipline of undergraduate study, and years in the engineering workplace. The nine participants in this study consisted of a uniform population in accordance with the research criteria—Black women with 10 or more years of experience in the engineering workplace. While there is variation in the years of service and industry sector of the participants, that difference is largely due to the scarcity of Black women in engineering. Had we tried to limit the sampling to a specific engineering discipline or narrow band of years in industry, we may not have been able to identify and recruit enough participants. The targeted years of service were driven by occupational theory, that suggests that 10 years is when a person begins to experience stabilization and is less likely to change professions (Swanson & Fouad, 2014). To gain enough participants for the study, the few women who responded to requests to interviews were asked to identify or refer other women who met the target sample population to participate in this study through a snowball sampling method (Creswell, 2013). Given the stark paucity of Black women in engineering industry, snowball sampling was most appropriate for contacting participants from a broad swath of experiences, locations, and engineering industries. There were no external incentives given to participants. The participant details are outlined in Table 1. The diversity of the engineering major, industry type, and geographic location provided an opportunity to see the common ground that these Black women share, regardless of background.

TABLE 1 Participant information

Pseudonym	Undergraduate university	Major	Industry type	Years of exp.	Title	Geographic location	Origin
Savannah	HBCU	Mechanical	Government	30+	Sr. Executive	South Region–South Atlantic Division	Northeast Region–New England
Mirriam	PWI	Civil	Manufacturing	19	Director of Manufacturing Operations	Midwest Region–East North Central	Midwest Region–East North Central
Victoria	PWI (several)	Mechanical	Medical	15	Analyst	Midwest Region–East North Central	Midwest Region–East North Central
Brittany	HBCU	Chemical	Consumer products	10	Supply Chain Manager	South Region–South Atlantic Division	South Region–South Atlantic Division
Inez	PWI	Biomedical	Medical	12	Senior Operations Engineering Program Manager	Northeast Region–Middle Atlantic Division	Northeast Region–Middle Atlantic Division
Patricia	PWI	Mechanical	Automotive	26	Program Manager	Midwest Region–East North Central	Midwest Region–East North Central
Kerry	PWI	Electrical	Automotive	14	Product Manager	Midwest Region–East North Central	Northeast Region–Middle Atlantic Division
Chloe	HBCU	Chemical	Automotive	20	Integrator	Midwest Region–East South Central	Midwest Region–West North Central
Leoni	Foreign	Electrical	Internet retailer	18	Analyst	West Region–Mountain Caribbean	Caribbean

Abbreviations: HBCU, historically black colleges and university; PWI, predominantly white institution.

FIGURE 1 Sample interview protocol

I would like to break the ice by first getting to know you ... tell me about yourself, where are you from?
 [PROBE]: What types of things are important to you?
 [PROBE]: What is important to being [insert name here]?
 Can you walk me through how you decided to go into engineering?
 [PROBE]: Can you tell me more about when you were [insert undergraduate institution here]?
 Tell me about your career in engineering leading up to the present.
 What does it mean to be an engineer for you?
 [PROBE]: Can you walk me through an example of a time when you experienced?
 [PROBE]: Interesting. I think I understand what you mean. Can you elaborate on what you mean by that?
 [PROBE]: This may sound like a silly question, but can you tell me more about what you meant by ...?
 Can you walk me through a typical day at work?
 [PROBE]: What kinds of things are you doing? Does it change from day-to-day?
 [PROBE]: Describe your work relationships.
 Describe ways in which you feel recognized as an engineer...
 [PROBE]: ... at work.
 [PROBE]: ... outside of work.
 Do you feel like you have been successful as an engineer?
 Now that you have talked about how you came to your career, and what it is like to be an engineer, what does being an engineer mean to you?
 How do you feel your identity as a Black woman has shaped your experience?
 How about as a ... [whatever identities have surfaced in the interview]?
 How did you come to this understanding?
 Do you want to continue in engineering? Why or why not?
 Have there been parts of your life where you haven't wanted to? What kept you going at it?
 If you were to give yourself advice when beginning your career, what would it be?

5.2 | Data collection: In-depth interviews

We conducted semistructured interviews with the nine participants, which ranged in length from 92 to 123 min. Because the participants were geographically located in a diverse range of settings in the United States, we employed telephone interviews for data collection. All interviews were conducted by the first author, and the audio recording of the interview was transcribed by both the first author and a professional transcriber. All study procedures related to the interview were approved by the institutional review board.

The goals of the semistructured protocol were to elicit in-depth expressions related to each of the participant's experience of identity (see Figure 1). We began the interview by providing ample time for developing rapport with each participant and then gradually shifted the conversation to asking questions about their background or pathways to engineering, work experiences, and identity meaning-making. Identity meaning-making refers to questions that ask participants to be reflective about their feelings or perceptions around their self-ascribed identities, that is, *how do you feel your identity as a Black woman has shaped your experience as an engineer?* The meaning-making element of the interview is fundamental to the execution of IPA; it provides a mechanism for revealing a person's understanding of their experience of a phenomenon.

5.3 | Data analysis

The analytical procedures for deeply understanding the lived experience of identity in the nine participants were guided by the philosophical underpinnings and researcher mindset required for strong IPA research (Huff et al., 2014; Smith et al., 2009). Throughout the data analysis, our procedures helped us to unpack the lived experience of each individual participant before cautiously moving to interpreting findings held collectively by the group of participants. In this regard, we were able to generate cohesive knowledge claims about the psychological lived experience shared by the group of participants while also doing justice to the idiosyncratic nature of how each participant experienced their personal identity.

More specifically, data were collected from all of the participants prior to beginning analysis. After each interview, the lead analyst (first author) engaged in reflection and captured preliminary thoughts as "reflective remarks" in a "contact summary sheet" (Miles & Huberman, 2014). Reflective remarks consisted of emergent themes and raw connections to theoretical frameworks. Once all of the interviews were completed, the lead analyst began data analysis by first listening to the audio file of an interview with a single participant to guide reading the text with specific nonverbal features of the interview (e.g., tone, pauses, laughter). During the initial read through of the transcript, no notes were

taken allowing attention to only the audio. Smith et al. (2009) described this part of the process as an opportunity for “slowing down our habitual propensity for ‘quick and dirty’ reduction and synopsis” (p. 82). Next, the lead analyst engaged in the process of *horizontalization*. Horizontalization consisted of reviewing interview transcripts and highlighting significant statements or quotes that provided an understanding of how each participant experienced the phenomenon individually (Creswell, 2013; Moustakas, 1994). This process was dependent on a line-by-line analysis of the experiential claims and understandings of each participant (Smith et al., 2009). This phase consisted of a minimum of three passes through the transcript, each time focusing on a different form of commenting: *descriptive*, *linguistic*, and *conceptual* (Huff et al., 2014; Smith et al., 2009). The *descriptive* commenting captured a description of the content of the participants’ words. The intent of this pass was to summarize the point of the statements that the participant made. The *linguistic* commenting explored the language choice of the participant. This pass identified the words the participant used and the tone in which she delivered her narrative. In some cases, the linguistic analysis included identifying the use of metaphors, hyperbole, pronouns, repetition, and other notable patterns of speech. The *conceptual* commenting often took an interrogative form, such that the analyst cautiously asked questions about the patterns of meaning found in the transcript. In this regard, the analyst blended prior theoretical insight alongside the lived experience of the participant. However, in asking questions (rather than declaring statements), the analyst committed to an open mind toward understanding the participants from their lived experience with careful interpretation of how such experience aligned with existing theory. The three layers of commenting were then used to develop themes for each participant. Each case then resulted in the development of a concept map of all of the themes that emerged. The nodes of the concept map consisted of the theme, a description, and the location of the theme in the transcript (by line number). The themes were subsequently clustered based on the similarities among the themes. These translated to superthemes or an overarching theme/description. The details of these annotative procedures are described thoroughly in our previous work (Huff, 2014; Ross, 2016).

The analytical procedures reflected a commitment to establishing an idiographic understanding of each participant as a case on its own terms. The annotations within the transcripts provided a tangible mechanism of carefully developing inductive themes that were well-justified within the textual data. Furthermore, the author team met in frequent cycles throughout the analytical process to check the lead author’s emergent insights that were developing within each case. Only after each one of the cases had been analyzed in-depth according to the procedures described did we move on to carefully consider patterns that were established across the entire dataset. Such a commitment to ensuring a careful hermeneutic understanding of each participant before moving on to the entire group is in line with the highest standards of IPA for trustworthiness (Smith, 2011) and is also well-aligned with making visible the social phenomenon of this investigation, namely, individual engineering identity (Walther et al., 2013).

The procedures of our cross-case analysis were accomplished through an in-depth commitment by the research team to assure that themes were established based on case-based findings. Specifically, the first author printed all of the superthemes from each case out on paper, cut, and rearranged the superthemes across all of the cases/participants in order to glean the superordinate themes across all of the participants. While the themes were not quantified, further examination was given to themes that demonstrated dominant clustering—meaning most of the participants described similar experiences or described experiences similarly. Additionally, we were attentive to capturing tension among themes and hierarchical relationships within the dataset, not only recurrences. In summary, there were 33 themes and 84 subthemes that were organized into clusters of six superordinate themes. In particular, we leveraged subthemes to help deconstruct the complexity of a superordinate theme. While these themes are fully documented elsewhere (Ross, 2016), we use this manuscript to report one of the superordinate themes—resilient engineering identity development. We made this decision to demonstrate the richness and significance of the superordinate theme in order to demonstrate both coherence and complexity in the findings reported below.

5.4 | Positionality

This paper’s first author conducted all interviews and led the analysis efforts for each of the participants. Accordingly, we make known the position of this author and her experience of the phenomenon under investigation. Throughout the study, this investigator leveraged her personal background with the study’s focus to develop a shared experience between her and the individual participants in the interview process. Additionally, the investigator also enrolled a broader community (i.e., the second and third authors) in the analysis to critically question the findings, ensuring that they were strongly supported in the transcript data and were congruent with the theoretical framings of this work.

5.4.1 | First author positionality

Being critical in reflecting on my positionality, I explicitly acknowledge the elements that influence my interpretation of the research findings: my race, gender, experiences in engineering and in industry, and exodus from industry are all elements of my position as the researcher or instrument of data collection. Engaging in this study, I am aware of my preconceived knowledge of being a Black woman, an engineer, and my previous experience with work culture and environment. Constant reflective practice throughout the research process raised awareness of this influence on research interpretation. My background provided insight, but it also pushed me to see each participant as having unique journeys. Constant self-reflective practice through journaling in conjunction with feedback from my research team and peers aided in acknowledging bias inherent to my participation in the study. Acknowledging this potential bias does not eliminate bias; it simply adds transparency to the research process.

5.5 | Findings

This study answers the three research questions focused on how our participants developed identities as Black women engineers, experienced these multiple identities in engineering industry, and developed resilient identities to remain in engineering fields for 10 years or more. The participants in this study found their way to engineering by familial influences, informal learning experiences, encouraging teachers, and interest in math or related subject areas. Once on a pathway to engineering fields, they were introduced into environments that encouraged and nurtured the convergence of their identities as Black women engineers.

The identity literature often suggests that there are two phenomena at play when an individual recognizes the existence of multiple identities: (1) that competition might arise among the multiple identities or (2) that the identities exist in a constant negotiation between structure (external) and agency (internal). The participants in this study, however, demonstrated power and resilience in negotiating their multiple identities into a congruent understanding of their own selves in the context of engineering. The women in this study described through their journey to and through engineering as Black women engineers, not merely as Black, women, engineers. This difference is subtle yet powerful and speaks to the supports that enabled the negotiation of a congruent identity. Our participants highlighted the value and benefit of having spaces—minority engineering programs (MEPs), engineering ethnic professional organizations (EEPOs), historically Black colleges and universities (HBCUs)—that aided in facilitating this convergence of identities typically considered outside the norms in engineering. Below, we describe how these particular spaces functioned as structures to support this holistic identity development as well as how each individual enacted agency to reshape her engineering environments (e.g., particular unsupportive structures) to negotiate her identities for long-term participation in engineering. This engagement with structures and agency highlights the delicate interplay between these concepts and provides rich descriptions of how these women formed resilient engineering identities.

5.5.1 | Structures

Identity theorists have debated the impact of social structures on the development and sustainability of identity in individuals. When examining the experiences of the women in this study, there were three structures that were critical to the development of their resilient or convergent identity—HBCUs, MEPs, and EEPOs. Six of the nine participants talked about how these structures influenced or impacted their perception of self in engineering as Black women. In this section, we will present evidence of the impact of these structures on the development of their convergent, salient identities as Black women engineers, beginning with HBCUs.

Some participants were deliberate in their election to attend an HBCU because of the promise it presented with regards to having Black role models and models of Black academic excellence. Their university provided a context where excellence in STEM of Black people was the norm. They had Black scholars as faculty and Black peers who excelled and challenged their own expectations, stereotypes, and understanding of who could be engineers:

In the back of my mind I always had this idea that I wanted to go to a HBCU and that's because as a Black female in high school I didn't see a lot of people in my classes that looked like me. If I wasn't the only one, there may have been one or two others when I was in high school. ... I didn't see a lot of people in my core

classes that looked like me, which is why I had to make sure I took a lot of good electives where I knew it was going to be a lot of brown people. Yeah, I didn't see a lot of people that looked like me. That was kind of what fueled [my decision to attend an HBCU], I know that there are a lot of smart Black kids and so in the back of my mind I was always like, "I want to go to a HBCU for that reason." ... Then I did research, [HBCU] actually being the largest school that graduates Black engineers, hey, why not? I had full rides to other school but they weren't [HBCU], so I chose to not take a full ride to go to [HBCU] over a school that I had full ride at. ... Again, when I first got to school, and I would see, I was like, "These are some smart, smart kids." Not because they were Black, it was just this was the first time I had the chance to be involved in study groups. I didn't have study groups when I was in high school because I had to study alone. It was the first time that I had study groups and we would just stay in the library or wherever we were for hours. I was like, "These are some really, really bright kids." I realized when I got to college, I wasn't as smart as I thought I was because there was some kids that was like oh my God, they were genius level. (Brittany)

Others chose the path of an HBCU after first experiencing the challenges associated with attending a PWI as a Black woman in engineering. One such example was Savannah, who upon graduation had her heart set on attending a large PWI in Boston, where she could participate in cooperative education opportunities as well as pursue her studies in mechanical engineering. However, these aspirations were thwarted by racial turmoil in the Boston area at the time. Her parents decided perhaps a small college in western New England would be best. Unfortunately, she described this experience:

I didn't like it because it was being around people who'd never seen Blacks. The teacher, one of their engineering teachers, was like, "I don't think women should be an engineer and I'm going to do everything I can to get you out of these classes." (Savannah)

This experience prompted her to transfer to an HBCU. She described her experience at the HBCU as "totally different":

Being exposed to people who ... a couple of the professors had went to MIT when they were in their 20s and to college when they were 15 and 16. (Savannah)

Savannah's role models were nurturing, supportive, and defied all of the stereotypes that she had been exposed to at her previous institution. She interacted with her first African American woman engineer and was taught by women faculty (also anomalies at her previous institution). She developed lifelong relationships at her institution and credited these, 30 plus years into her career, for helping her to remain engaged in engineering:

When I got to [HBCU] it was just a totally different experience. ... You get to see a lot of role models, very strong role models. That was the first time I really had interactions with African American female engineers. ... There were actual female instructors there. ... I can say now that I developed lifelong relationships. I think that was important for me, and it still is. Being able to develop those strong relationships in undergrad, and even with my professors and my fellow classmates. I think that's one thing that's helped me navigate and be able to stay in the field for so long. I can go back and talk to them. ... I think that helped me because you can go back when you're hearing these ignorant statements and stuff about Blacks and engineering and their ability I could go back to [HBCU], to my roots, and see that that's a farce and they just don't know. ... It's ignoring and learning that a lot of these stereotypes that we learned over the years just don't carry any weight. ... I think that helped me. (Savannah)

Savannah described her experience with Black women engineering instructors as important to her development during her undergraduate studies and in her current navigation of the engineering workplace. These Black women engineers were role models for her identity development.

Meanwhile, Chloe, a chemical engineering major with 20 years of experience in the automotive industry, had a similar experience at the HBCU that she attended. She described the environment as being supportive:

I had the support. I think that may have been from going to [an] HBCU, it was a smaller school. ... The engineering school, once you got into the engineering school was a close-knit community. ... We could

have study groups into the wee hours of the morning. At times we got together and studied together and made sure that we all were getting the material. I would say it was a supportive environment. (Chloe)

The women in this study who attended an HBCU for their undergraduate engineering studies described an environment that fostered an opportunity to learn engineering without the distraction and complexities associated with the hyper-awareness of race and gender in predominately white spaces. They were surrounded by scholars, educators, and peers that reflected their likeness and thus relieved them of the burden of focusing on stereotypes. In contrast, some participants elected to attend a PWI; however, to augment their experience, they sought out the support of MEP programs:

[MEPs] were support programs that once they recruited you into the college of engineering, they kind of gave you some resources, tips, mentors, things that I would say a minority needs on top of the general population. ...The best part of it [MEP] was ... having that support group between the women engineering program and minority engineering program ... the mentorship, the encouragement, the heads up, the extra tips on how to get a job, stuff that our parents probably couldn't tell us how to do but they knew how to do it and if you were willing to listen and go to meetings, they spent the time with you and they kept you on the right track. If you don't take advantage of those programs while you're on campus, I don't know how you get out with an engineering degree. (Kerry)

In Kerry's case, the director of the MEP was a Black woman role model who had a successful engineering career and then returned to the academy to impact those who followed her: "She's always still trying to help the engineers behind us. She was an engineer herself which I think helped as well. She was in the industry for a little bit before she came over to [PWI]. ... We had weekly meetings or monthly meetings because she wanted to make sure we graduated." Kerry mentioned how the presence of a Black woman engineer served as a role model during her undergraduate engineering experience. She alluded to how this combination of identities helped her develop in the engineering environment. This sentiment expressed by Kerry was also represented in the interviews with Victoria and Mirriam.

Victoria's exposure to MEP programs began in high school, but they supported her throughout her undergraduate engineering pursuit. She described MEP outreach programs as the reason she selected engineering as an occupation, and when she recognized she was struggling at her PWI, she found herself reliant on MEPs again to matriculate:

I had a physics teacher who encouraged me to go to a program at [Midwestern university] called MEAP, the Minority Engineering Advancement Program and that's really when I first began to even think about engineering. ... That's another thing that was really positive. This was called Project Enter Phase. It was targeted to minority students and we had courses ... it was like an early dive into college level calculus and physics and some things like this. (Victoria)

Mirriam recounted a similar dependence on the MEP at her institution in order to establish a community at her PWI:

It was real hard to get acclimated in the beginning. But that quickly passed because I got involved in the minority engineering program that ... was running at the time. ... Through that effort, I really met a lot of the rest of us [Black engineering students] and started building those relationships. ... I had to dig in and find some folks to fit in with. I mean, you know? There's not a whole lot of us looking like us and I think it's much the same today, which blows my mind. (Mirriam)

In the absence of an established MEP program, some participants leaned on the structure and support created by a local NSBE chapter. Victoria and Inez both reflected on how NSBE provided community and a space to find study partners:

I was a member of the National Society of Black Engineers. I went to a lot of conferences, regional and national conferences, and I don't know. I was more involved in activities in general. That involvement made me feel like I was supported and I belonged. So much so, that when I completed my degree and joined industry...the absence of Black people at work, pushed me to seek out a NSBE alumni chapter to find a community. (Victoria)

When I was an undergrad, I mentioned academic excellence workshops. Just like having study groups amongst yourselves. I would say most of the people in my study groups, most of them were NSBE members. We went to conferences together, whether they were regional conferences or national conferences. We were a tight knit group as undergrad. (Inez)

As often seen, in large universities, minority student experiences in MEPs are augmented by the presence of EEPOs such as the National Society of Black Engineers and Society of Hispanic Professional Engineers. There is a clear delineation between the two structures, but in some cases, they are colocated and blended, namely due to the overlap in population. Such organizations were often mentioned by participants as another structure that provided an environment, community, and foundation for success in their engineering education. EEPOs provided a mechanism for battling isolation and fostered a sense of belonging.

MEPs and HBCUs provided external supports, structures, or opportunities for these students to be free to focus on their academic achievement without the burden of race and gender. Likewise, these participants were surrounded by role models and peers that were of the same gender and race. Experiences such as these challenged their ideas of who belonged in engineering. This new framing that included peers and role models who looked like them added to the salience and subsequent resilience of their Black woman engineer identity.

5.5.2 | Agency

External structures such as MEPs, EEPOs, and HBCUs provided role models, safe spaces, and learning communities with less racial and ethnic tension; however, there were also agentic factors that contributed to the resilient engineering identity development and sustainment of these women. When necessary, the women in this study reauthored their definition of engineering to include their Black woman identity. While the structures created an environment to foster an engineering identity, their agency empowered them to define an engineering identity that encompassed all of their identities—Black, woman, engineer. This reauthored engineering identity not only included their multiple identities but it also included their priorities. Instead of conforming to the norms of the engineering environment, they established new norms on the basis of their priorities, interests, and needs to remain engaged.

Savannah identified as a Black woman engineer through her educational pursuits, her relationship with her role models, and her current role in the workplace, in her own words, “I’ve never felt the need to deny that I’m an African American. I did go to a historically Black college and I can figure out engineering.” This commitment to her racial and gendered identity aided Savannah when she began her career in engineering as she was constantly reminded, she was an anomaly:

At work, I guess the first week I was at the [government agency] and everyone said, “Oh, we have an African American female engineer,” people would stick their head in my office just look at me and walk away like some kind of zoo animal. I told the secretary, I said, “Put a box out there that says she likes chocolate.” I didn’t have a name. It was, “That’s her. There she is.” It was such, I guess, a phenomenon. They’d never seen an African American female [engineer]. We would brief the commission who are the presidential appointees to the agency. I was always, “There she is. That’s her,” so I said, “I have to get some more people in because I can’t keep being the only one.” ... At work, I guess the first week I was at the [government agency] and everyone said, “Oh, we have an African American female engineer,” people would stick their head in my office, just look at me and walk away. Like some kind of zoo animal. ... I remember people saying to me, “Do you really have a degree in engineering, it’s not engineering technology.” ... I think, as a Black woman, I just shattered a lot of stereotypes that people have. (Savannah)

Savannah’s mechanism for thwarting the incessant reminders that she did not embody the racial and gendered characteristics of who belongs in engineering was to actively recruit others who looked like her. Savannah saw her role as a Black woman engineer as also embodying activism through recruitment efforts:

It was my natural inkling to help with the recruiting and help with mentoring, so I was getting awards for helping ... and civil rights and being woman of the year award [winner] or being recognized by the American Society of Mechanical Engineers. (Savannah)

Her reauthored Black woman engineer activist identity won her awards, accolades (locally and nationally) and helped her to navigate a tough career. She saw this new identity as a means for coping with the spectacle of being a Black woman in engineering in her field, “I am recognized, ... because I am a Black woman engineer who’s willing to help reach back.”

Victoria also described an environment that did not provide space or privilege to *only* be an engineer. She was instead the Black woman engineer:

A lot of places that I worked and a lot of classes that I had, I was the only woman, definitely the only Black in a lot of classes. ... It can feel isolating sometimes when you don’t see people who look like you. ... I think there’s only been one other Black woman in the product development group the whole time I’ve been at [medical company 1]. We had some summer co-ops, but there was only one Black woman engineer in the product development group while I was there. ... I guess in some ways, I was easily identified because they didn’t have to say my name, they would just say you know, the Black woman in knees [the product area she worked in]. (Victoria)

These common experiences across the participants of having to manage and negotiate what being a Black woman in engineering meant often inspired them to re-evaluate their priorities and values in order to align them with self. Self-awareness, self-management, and negotiation often resulted in a reauthored engineering identity that embodied their whole selves.

Mirriam developed agency to own her career to ensure priority alignment: “I think taking ownership of those things and letting people know who you are and who you’re trying to be in life kind of frees you up to be you.” This need or desire to align her career with who she was fundamentally pushed her to reauthor her engineering identity to include being Black and a woman. She recounted a story where these identities were in conflict for her colleague and she was determined to not allow his conflict to be her conflict:

There was a guy that sat in the cubical area. His name was [redacted] and he had a big belly and wore suspenders and he was bald on top. He looked at me one day across the cube. He said, “Hey!” I’m like, “what?” He was like, “you’re not supposed to be here.” I look and I said, “what do you mean I’m not supposed to be here?” [And he said,] “I just never was supposed to work with a woman in engineering, let alone a Black woman.” He spun around in his chair and went right back to work. (Mirriam)

These constant reminders of one’s social identity in the context of the engineering workplace was a common theme across the participants. This phenomenon, was experienced in all sectors of industry and served the basis in some cases for why these women would not or could not ignore their identities as women, Black and engineering as mutually exclusive. As such, they converged them:

“Hey, hey. Can I talk to you for a second?” I said, “Yeah.” He said, “You’re the new quality manager here?” “Yes.” “Oh okay. Do you drive that black [car make and model]? that’s outside?” “Yes, I do.” He said, “I knew it! I knew it! I’m always ... When I’m at home and night and watch TV, I see commercials for that car all the time and I told my wife just last night, ‘Hey, hey honey. Look, look. The new colored girl at the plant drives one of those!’” (Mirriam)

However, it was more than just a statement that she carried the rest of her career. It was the impetus for being deliberate in describing herself in this interview and when talking to others as a Black woman engineer, not just an engineer.

Chloe also described this need to expand the traditional engineering paradigm to include actions and opportunities that contributed to a more holistic view of engineering that would include self:

I came here [company] doing engineering but I also do other things. I’m involved with the recruiting for that piece that I need to feed. ... Me, joining the team, and going back to my alma mater to do recruiting. That was helping to feed another part of me to sign up with recruiting with NSBE and talking about the company being involved in and helping other people get to where they want to be. (Chloe)

Creating space and opportunity to introduce a whole self, inclusive of both engineering as well as social identities, into the engineering workplace not only aided in battling isolation it also provided the agency to reauthor engineering identity and challenge perceptions about who was welcomed to participate in engineering. This reauthorship took the form of altruistic endeavors—mentoring, recruiting, and so forth. But this agency also took the form of seeking positions within their respective companies that better aligned with their immediate needs. These needs, at times, included less demanding roles (young family), more challenging roles, leadership roles, and roles requiring skill sets outside the scope of their formal training. These occupational maneuvers allowed these women to embrace themselves in totality—Black women engineers. Embracing and celebrating their complete identity then empowered these women to celebrate their uniqueness in the space of engineering:

If you can maneuver through that experience where you're a minority in any situation or environment, then you can stand up for new ideas, for innovative concepts, for engineering and leading a project. I think that's where the fact that I happen to be an African American woman is an advantage because some of my counterparts haven't had that same experience built up in them over time. You know, I'm comfortable walking into any room because I have been all my life. I didn't have a choice. (Mirriam)

The women in this study, those who had stayed in engineering for 10 years or more, described a process of developing identities as Black women engineers through the supportive structures at their respective universities early on in their engineering education. In the workforce, these women had to reauthor the spaces in which they worked to support those identities. This process of navigating the tension in structure and agency developed resilient and congruent identities. These women were not only able to “survive” in an engineering culture that is often exclusive (Godfrey & Parker, 2010) but were also able to celebrate who they were. The development and sustainment of a resilient engineering identity, one that would sustain the challenges in the engineering workplace, was fostered in nurturing environments created by MEPs, EEPOs, and HBCUS (or some combination thereof) and reaffirmed by intentional and agentive efforts to reauthor engineering to include the confluence of their multiple identities.

6 | DISCUSSION

Identity has been used as a framework to better understand engagement and persistence in STEM fields. Scholars have determined that formulating a STEM role identity is critical to an individual's continued engagement in these fields. It has also been demonstrated that structures and environment can support and influence the development of a role identity. The complex relationship between identity agency and structures, often referred to as the structure-agency dialectic, can have both negative and positive implications for the development of one's role identity. Scholars have demonstrated that people have multiple identities (e.g., woman, Black, engineer, scientist) and often these identities are in competition. This competition among identities has prompted a body of literature around disengagement in STEM fields due to an incongruence and likewise, reordering of identities based on race and/or gender identity (Kyriakidou, 2011). However, the women in this study developed an engineering identity that consisted of the confluence of their multiple identities. This phenomenon is described below as *resilient identities* and was described by the participants as the result of *reaffirming structures*, also described below.

6.1 | Resilient identities

Resilience is defined as “the process of adapting well in the face of adversity, trauma, tragedy, threats or significant sources of stress such as ... workplace” (America Psychological Association [APA], 2014). Some factors identified as contributing to the development of resilience include caring and supportive relationships within and outside of family along with a positive view of yourself and confidence in your strengths and abilities (among other things; APA, 2014). The construct of resilience in combination with the construct of identity yields a resilient identity. A resilient identity is a consistent view of oneself in spite of contexts that threaten the congruency of those multiple identities. In this study, our participants were able to claim identities as engineers along with their Black women identities as a holistic description of themselves. They negotiated these identities in the face of workplace cultures that were exclusive and tried to erase their social identities or signal that they did not belong. The women in this study described their resilient

engineering identities as a result of structures and agency that inform and confirm identities that are largely outside the norms in engineering—being a Black woman engineer.

Previous literature would suggest that being a woman, being Black, and being an engineer are incongruent and, thus, should result in competing identities that shift and shuffle based on context leading to disengagement and attrition (Foor & Walden, 2009; Powell, 2009); however, the structures established by MEPs, EEPOs, and engineering programs in HBCUs coupled with agency resulted in Black women self-ascribing the identity of Black woman engineer to themselves. In the workplace, the predominately White structures galvanized a sense of what it meant to hold on to that developed identity as a Black woman engineer. The women in this study, those who had persisted, not only had strongly developed identities or identity salience but also the awareness of particular structures in the workplace and the agency to reauthor their identities and workspaces to work for them. These women not only created a congruent place for them to exist in engineering, but they also celebrated that space and who they were. The confluence of their multiple identities resulted in a resilient engineering identity that would sustain them through a lengthy successful industry career despite being reminded almost daily that they were not expected to be in engineering.

These findings align with the claims put forth by Black feminist theorists who have long stated that in the absence of opportunity to ignore or disregard race and gender, Black women have long “crafted identities designed to empower them” (Collins, 2000, p. 108). The women in this study demonstrated that they are “resisting by doing something that ‘is not expected’ of them”—engineering (Collins, 2000, p. 108). As demonstrated by the women in this study, Black women have historically had the ability to cope with and transcend oppressions of race, class, and gender by creating independent self-definitions (Collins, 2000). In the context of Black feminist theory and among intersectionality theorists, identity is not the goal but rather the point of departure in the process of self-definition. This self-definition or reauthoring is a means by which to challenge or protest the externally defined or ascribed ideal of African American or Black women. When Black women define themselves, they are rejecting the assumptions and stereotypes used to confine them to a subset of occupations and thus confront and reclaim the power from those not entitled to do so. They are Black women engineers in part due to the historical need to do so out of survival; in part due to the systemic reminders in engineering that does not allow them to forget that they are Black and they are women; and in part due to the reaffirming structures (HBCUs, MEPs, EEPOs) that allowed them to even see this convergent identity as plausible.

6.2 | Reaffirming structures

Diversity and inclusion champions and scholars in engineering have long reported on the benefits of MEPs on the persistence of students in engineering (Good et al., 2001; Hermond, 1995; Lam et al., 1999; Lee & Matusovich, 2015; Morrison & Williams, 1993), noting the community, support structures, and environment put in place encourage minority students and contribute to persistence at PWIs. Scholars describe impacts such as confidence building, skill development, social engagement, and academic workshops that contribute to success in engineering. One construct seldom reported is development and sustainment of the confluence of multiple identities. This research examines the ways in which Black women in engineering were able to not only develop but sustain their multiple identities in industry.

In our study, the microenvironments that existed in MEPs provide the context for merging participants' identities rather than seeing them as competing. Similar results were reported in EEPOs (e.g., National Society of Black Engineers [NSBE] and the Society of Hispanic Professional Engineers [SHPE]; Revelo Alonso, 2015; Ross & McGrade, 2016). Students who actively engaged in these organizations described them as having provided an environment or a community where they saw engineers that “looked like them,” and family or *familia* of support. These organizations and likewise these MEPs provide a community of practice that not only embodied the professional gathering of people with the shared role identity of engineer but also the shared racial/ethnic identity. Similar to any community of practice (Lave & Wenger, 1991), these organizations provided opportunities to foster and nurture a resilient identity that encompassed more than one of participants' many identities—race, role, and sometimes gender. The structures were the MEPs or EEPO. The agency was their reauthoring of the definition of engineering to include their Blackness and their womanhood. This confluence of identities resulted in an identity that would serve as a barrier against stereotypes, bias, isolation, and other factors that lead to attrition.

The environment created inside engineering programs at HBCUs, similarly, established a space for their students to foster a resilient engineering identity. HBCUs have been acknowledged as creating a space where students experience far less social isolation, dissatisfaction, and perceived or real discrimination (Gary, 2010). Much like MEPs and EEPOs, there was a space to envision themselves within the context of engineering, not as an outsider but instead as the norm.

These images and identity development were reinforced, in some cases, by the presence of professors and instructors who served as role models, champions, and mentors to these women as they began their training in engineering. They were learning content knowledge as well as context knowledge, for example how to persevere and persist not just in engineering undergraduate but in graduate school and/or industry. While some of the women spoke of being insulated within the context of an HBCU, others spoke about how their faculty warned them of the challenges that await along with strategies for navigating the predominantly White, male engineering workforce. Each of the participants in this study recounted how the environments in their undergraduate experiences were critical to their prolonged engagement. Whether it was the relationships they established that they sustained, the role models, or the sense of community; they all referenced the environment as being instrumental to their persistence.

Our work provides specific examples of how support structures within undergraduate education helped to create opportunities for our participants' identities of being Black and a woman to have a career in engineering. The confidence that these structures gave to women during their development of an engineering identity during their undergraduate education provided not only ways for these women to find congruence among their multiple identities but also to have the agency to shape future structures in their workplaces to be spaces for them to exist and succeed. This research not only illustrates the importance of these programs during undergraduate education, as has been found in prior literature, but also the importance of developing congruence among underrepresented students' multiple identities for resiliency later on in their careers.

6.3 | Contribution

Prior literature on role identity suggests that lack of harmony among the variety of identities that one has been ascribed or has self-ascribed can result in competing identities, often leading to attrition. Likewise, there is a wealth of literature that highlights the overall attrition of women from engineering. However, the body of knowledge focused on race and gender in White male dominant fields has been limited to biculturalism and compartmentalization as coping mechanisms for persisting in these fields (Bell, 1990). These two mechanisms, while effective in retaining Black women in engineering, are similar to the competing identity theory. Competing identity theory suggests that people arrange their identities in hierarchy. They are not convergent or congruent but instead ranked based on cultural or environmental context. Likewise, biculturalism and compartmentalization require that a person isolate their identities and hide them based on cultural or environmental context. This study provides an alternative to identity construction theory to describe the resilient identity that encapsulated our participants' many identities as congruent rather than in conflict. It provides an expanded understanding of the mechanisms invoked for remaining engaged to aid engineering programs in justifying the establishment and/or sustainability of supportive environments at their institutions during the critical time of engineering identity development.

The findings highlight how, for the study participants, the combination of the environments provided by MEPs, EEPOs, and HBCUs and the agency to reauthor engineering identity to include their many selves aided in establishing harmony among their many identities. We connect this claim to McLean and Syed's (2015) master narrative framework, which described the formation of personal identity in the context of an individual perceiving and cocreating master and alternative narratives in the culture that embedded the individual. Specifically, they defined master narratives as "culturally shared stories that tell us about a given culture and provide guidance for how to be a 'good' member of a culture; they are a part of the structure of society" (McLean & Syed, 2015, p. 320). Based on literature previously discussed, it is well established that master narratives in U.S. engineering cultures are in no small part connected to broader identities at the intersection of White and male social categories. Furthermore, prior literature does well in discussion how Black women in engineering tend not to find themselves aligning with such narratives of the dominant culture.

However, consistent with our findings, McLean and Syed (2015) described how such individuals might use tools for personal identity development in ways that are informed by robust alternative narratives, that is, narratives that differ from or, in some cases, resist the master narrative. In the context of this study, the participants found that HBCUs, MEPs, and EEPOs provided them with the opportunities to internalize and contribute to well-established understandings of what it meant to thrive as an engineer within the frame of being a Black woman engineer. Supported by a cultural frame where they found belonging, these participants were able to author their own identity paths within contexts where they might have found themselves isolated on account of their integrated race and gender identities.

This confluence of identities resulted in a resilient engineering identity that allowed them to see their identities as congruent and not in competition. Borrowing from Tracy and Trethewey's (2005) metaphor, the participants cultivated a *crystallized* form of self in relation to their identities as Black women engineers. They describe the "crystallized self" as "multidimensional—the more facets, the more beautiful and complex. ... Crystallized selves have different shapes depending on the various discourses through which they are constructed and constrained" (Tracy & Trethewey, 2005, p. 186). They proposed this metaphor as an alternative to the more wide spread view of identity in the workplace—where individuals belonging to marginalized social groups (such as those in this study) are constrained to artificially perform a professional role in a way that is disconnected from how they understand themselves (Tracy & Trethewey, 2005; see also Faulkner, 2000; Huff et al., 2018).

Instead of their identities residing in a hierarchy, the participants now understood their multiple roles to be unranked, all contributing to a core integrated sense of identity. This result is in line with research conducted by van Hoof and Raaijmakers (2003), which established holistic identity formation to consider the integration of identity in a variety of specific contexts. In particular, they discussed vertical integration of identities to describe "the extent to which context-specific identities are incorporated into a core or predominant identity" (van Hoof & Raaijmakers, 2003, p. 282). In this study, the participants were in a work context in which their race and gender were made salient to them. But rather than avoiding the workplace setting that sought to marginalize them, they cultivated a sense of core identity that integrated their race, gender, and professional role as engineers.

It is worth noting that these interviews were conducted with individuals who have been engaged in engineering industry for more than 10 years. It could be that our participants struggled through competing identities and compartmentalization (and other factors that contribute to attrition) earlier in their career. Indeed, based on the findings, it seems likely that the psychological resilience demonstrated by the participants was built on the foundation of a time of navigating tension. However, the findings from this study suggest that we cannot fully understand the identity experiences of Black women in engineering without recognizing the strategies employed to sustain engagement instead of only examining the mechanisms that perpetuate feeling marginalized. By recognizing the power of the alternative narrative about being a Black woman engineer, we might better support students and professionals who might otherwise feel isolated and, thus, broaden the scope of the master narrative around engineering.

7 | LIMITATIONS

While the research addresses an evident gap in literature on Black women in engineering industry, there are limitations to the study. These limitations include the investigation of only one aspect of Black women's experience in the engineering workplace, identity. Experiences are multifaceted and multidimensional, and as such, this study is bound by the construct of identity and the way the study was framed. Another clear limitation is that the study, by its methodological design, did not capture a wide range of experiences among Black women engineers in workplaces. When designing this study, there were concerns about being representative of the many experiences of Black women including different industry sectors (e.g., government, commercial, nonprofit), different geographic locations (e.g., Midwest, East Coast, West Coast, South), size of the organization (e.g., small startup, large-scale Fortune 500), and years of service; however, the size of the study (nine participants) did not allow for such expansion, nor does the methodology require it. IPA is idiographic in nature and, therefore, is fashioned to give attention to each individual participant. Even though a selected sample of nine participants was not expansive nor representative of the population, the small sample allowed for the collection of data that were rich and detailed. The themes that emerged from this study were not exhaustive nor universal; they are, however, a glimpse into the experience of Black women in engineering. This study was designed to open the discussion about a subpopulation in engineering that is historically omitted from literature because of their small numbers. This research study is an attempt to amplify the voice of a demographic often unheard.

8 | CONCLUSION

Social identity theory has been leveraged in engineering to understand and explain engagement and persistence. Identity subconstructs have also been used to predict occupational pursuits in STEM fields. As such, this framework has provided a lens for evaluating factors that push underrepresented minorities out of the field of engineering, citing competing identity theory as one reason for disengagement. The current state of engineering being predominantly

White and male creates the perception that those who deviate from the social identity norm are incongruent with engineering and, therefore, chose to leave engineering and other STEM-related fields. However, this study presents a counter-narrative in which these Black women experienced the effects of a series of nurturing environments and structures that affirmed their engineering identity during development, resulting in a resilient engineering identity. Structures such as HBCUs, MEPs, and EEPOs have been lauded as contributing to the production of Black engineers by providing a number of factors like role models, communities of practice, academic support, and so forth. Universities, colleges, and industry should continue to support these structures. While these research results demonstrate the benefits of these structures of support, they in no way suggest that development of such programs will cure all of the challenges experienced by being a Black woman in engineering. Engineering as a discipline should still be challenged to be reflective about why these women needed to develop resilient engineering identities in engineering workplaces that frame Black women as out of place, not belonging, and incongruent with the norms. Persistence studies have reported that being able to see oneself in the context of engineering is critical to prolonged engagement, and this study contributes to this body of knowledge.

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REFERENCES

- America Psychological Association (APA). (2014). *The road to resilience*. Retrieved from <https://studentsuccess.unc.edu/files/2015/08/The-Road-to-Resiliency.pdf>
- Bastalich, W., Franzway, S., Gill, J., Mills, J., & Sharp, R. (2007). Disrupting masculinities. *Australian Feminist Studies*, 22(54), 385–400. <https://doi.org/10.1080/08164640701578765>
- Bell, E. L. (1990). The bicultural life experience of career-oriented black women. *Journal of Organizational Behavior*, 11(6), 459–477. <https://doi.org/10.1002/job.4030110607>
- Burke, P. J., & Stets, J. E. (2009). *Identity theory*. Oxford University Press.
- Butler, J. (1990). *Gender trouble: Feminism and the subversion of identity*. Routledge.
- Capobianco, B. M., Diefes-Dux, H. A., Mena, I., & Weller, J. (2011). What is an engineer? Implications of elementary school student conceptions for engineering education. *Journal of Engineering Education*, 100(2), 304–328. <https://doi.org/10.1002/j.2168-9830.2011.tb00015.x>
- 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 Teaching*, 44(8), 1187–1218. <https://doi.org/10.1002/tea.20237>
- Ceglie, R. (2011). Underrepresentation of women of color in the science pipeline: The construction of science identities. *Journal of Women and Minorities in Science and Engineering*, 17(3), 271–293. <https://doi.org/10.1615/JWWomenMinorSciEng.2011003010>
- Chubin, D. E., May, G. S., & Babco, E. (2005). Diversifying the engineering workforce. *Journal of Engineering Education*, 94(1), 73–86. <https://doi.org/10.1002/j.2168-9830.2005.tb00830.x>
- Clarke, S. (2008). Culture and identity. In T. Bennett & J. Frow (Eds.), *The SAGE handbook of cultural analysis* (pp. 510–530). Sage Publications.
- Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (7th ed.). Routledge.
- Cole, E. R. (2009). Intersectionality and research in psychology. *The American Psychologist*, 64(3), 170–180. <https://doi.org/10.1037/a0014564>
- Collins, P. H. (2000). *Black feminist thought* (2nd ed.). Routledge.
- Crenshaw, K. (1989). Demarginalizing the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. *University of Chicago Legal Forum*, 1989, Article 8. Retrieved from <https://chicagounbound.uchicago.edu/uclf/vol1989/iss1/8>
- Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3rd ed.). Sage Publications.
- Deaux, K. (2001). Social identity. In J. Worell (Ed.), *Encyclopedia of women and gender: Sex similarities and differences and the impact of society on gender*. Academic Press.
- DeCuir-Gunby, J. T., Grant, C., & Gregory, B. B. (2013). Exploring career trajectories for women of color in engineering: The experiences of African American and Latina engineering professors. *Journal of Women and Minorities in Science and Engineering*, 19(3), 209–225. <https://doi.org/10.1615/JWWomenMinorSciEng.2013005769>

- DeOrnellas, J. (2015a). From curious little girl to household breadwinner. Retrieved from <http://www.aauw.org/2015/03/09/stephanie-engineering-and-cybersecurity/>
- DeOrnellas, J. (2015b). I am the unicorn: A young woman of color prepares to enter the computer science workforce. Retrieved from <http://www.aauw.org/2015/03/19/i-am-the-unicorn/>
- Falkenheim, J. C., & Burrelli, J. S. (2012). *Diversity in science and engineering employment in industry* (NSF InfoBrief NSF12-311). National Center for Science and Engineering Statistics. Retrieved from <https://wayback.archive-it.org/5902/20181004073533/https://www.nsf.gov/statistics/infbrief/nsf12311/nsf12311.pdf>
- Faulkner, W. (2000). Dualisms, hierarchies and gender in engineering. *Social Studies of Science*, 30(5), 759–792.
- Foor, C. E., & Walden, S. E. (2009). “Imaginary engineering” or “re-imagined engineering”: Negotiating gendered identities in the borderland of a college of engineering. *NWSA Journal*, 21(2), 41–64. <https://doi.org/10.1353/nwsa.0.0078>
- Gary, S. (2010). *Historically Black colleges and universities in the development of Black science, technology, engineering, and mathematics Ph.D. students*. University of Pennsylvania.
- Gauntlett, D. (2002). *Media, gender and identity: An introduction*. Routledge.
- Giddens, A. (1984). *The constitution of society: Outline of the theory of structuration*. Blackwell Publishing Ltd.
- Godfrey, E., & Parker, L. (2010). Mapping the cultural landscape in engineering education. *Journal of Engineering Education*, 99(1), 5–22.
- Godwin, A., Potvin, G., Hazari, Z., & Lock, R. (2013). Understanding engineering identity through structural equation modeling. *Proceedings of the IEEE Frontiers in Education Conference*.
- Godwin, A., Potvin, G., Hazari, Z., & Lock, R. (2016). Identity, critical agency, and engineering: An affective model for predicting engineering as a career choice. *Journal of Engineering Education*, 105(2), 312–340.
- Good, J., Halpin, G., & Halpin, G. (2001). Retaining Black students in engineering: Do minority programs have a longitudinal impact? *Journal of College Student Retention*, 3(4), 351–364. Retrieved from <http://search.proquest.com/docview/196715564?accountid=13360>
- Hancock, A.-M. (2007a). Intersectionality as a normative and empirical paradigm. *Politics & Gender*, 3(2), 41–45. <https://doi.org/10.1017/S1743923X07000062>
- Hancock, A.-M. (2007b). When multiplication doesn't equal quick addition: Examining intersectionality as a research paradigm. *Perspectives on Politics*, 5(1), 63–79. <https://doi.org/10.1017/S1537592707070065>
- Hatmaker, D. M. (2013). Engineering identity: Gender and professional identity negotiation among women engineers. *Gender, Work & Organization*, 20(4), 382–396. <https://doi.org/10.1111/j.1468-0432.2012.00589.x>
- Hermond, D. (1995). Measuring the retention strategies of a minority engineering program: A service quality perspective. *Journal of Engineering Education*, 84(4), 395–400. <https://doi.org/10.1002/j.2168-9830.1995.tb00196.x>
- Honey, M., Pearson, G., & Schweingruber, H. (Eds.). (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research*. National Academies Press.
- Huff, J. (2014). *Psychological journeys of engineering identity from school to the workplace: How students become engineers among other forms of self*. Purdue University.
- Huff, J. L., Smith, J. A., Jesiek, B. K., Zoltowski, C. B., Graziano, W. G., & Oakes, W. C. (2014). From methods to methodology: Reflection on keeping the philosophical commitments of interpretative phenomenological analysis. *Proceedings of the IEEE Frontiers in Education Conference*. <https://doi.org/10.1109/FIE.2014.7044253>
- Huff, J. L., Smith, J. A., Jesiek, B. K., Zoltowski, C. B., & Oakes, W. C. (2018). Identity in engineering adulthood: An interpretative phenomenological analysis of early-career engineers in the United States as they transition to the workplace. *Emerging Adulthood*, 7(6), 451–467. <https://doi.org/10.1177/2167696818780444>
- Hughes, C. (2013). Engineer took all the right steps but still didn't receive fair pay. Retrieved from <https://ww3.aauw.org/2013/07/19/engineer-unfair-pay/>
- Johnson, A., Brown, J., Carbone, H., & Cuevas, A. K. (2011). Authoring identity amidst the treacherous terrain of science: A multiracial feminist examination of the journeys of three women of color in science. *Journal of Research in Science Teaching*, 48(4), 339–366. <https://doi.org/10.1002/tea.20411>
- Joy, E. (2014). The other side of diversity. Retrieved from <https://medium.com/thelist/the-other-side-of-diversity-1bb3de2f053e>
- Jungert, T. (2013). Social identities among engineering students and through their transition to work: A longitudinal study. *Studies in Higher Education*, 38(1), 39–52. <https://doi.org/10.1080/03075079.2011.560934>
- Kirn, A., & Benson, L. (2018). Engineering students' perceptions of problem solving and their future. *Journal of Engineering Education*, 107(1), 87–112. <https://doi.org/10.1002/jee.20190>
- Ko, L. T., Kachchaf, R. R., Hodari, A. K., & Ong, M. (2014). Agency of women of color in physics and astronomy: Strategies for persistence and success. *Journal of Women and Minorities in Science and Engineering*, 20(2), 171–195. <https://doi.org/10.1615/JWomMinorSciEng.2014008198>
- Kyriakidou, O. (2011). Negotiating gendered identities through the process of identity construction. *Equality, Diversity, and Inclusion: An International Journal*, 31(1), 27–42.
- LaFromboise, T., Coleman, H. L., & Gerton, J. (1993). Psychological impact of biculturalism: Evidence and theory. *Psychological Bulletin*, 114(3), 395–412. <https://doi.org/10.1037/0033-2909.114.3.395>
- Lam, P. C., Doverspike, D., & Mawasha, R. P. (1999). Predicting success in a minority engineering program. *Journal of Engineering Education*, 88(3), 265–370. <https://doi.org/10.1002/j.2168-9830.1999.tb00445.x>
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

- Lee, W. C., & Matusovich, H. M. (2015). Minority/multicultural engineering program impact: A student perspective of co-curricular support. *Proceedings of the ASEE Annual Conference and Exposition*.
- Litzler, E., Samuelson, C. C., & Lorah, J. A. (2014). Breaking it down: Engineering student STEM confidence at the intersection of race/ethnicity and gender. *Research in Higher Education*, 55(8), 810–832. <https://doi.org/10.1007/s11162-014-9333-z>
- May, G. S., & Chubin, D. E. (2003). A retrospective on undergraduate engineering success for underrepresented. *Journal of Engineering Education*, 92(1), 27–39. <https://doi.org/10.1002/j.2168-9830.2003.tb00735.x>
- McLean, K. C., & Syed, M. (2015). Personal, master, and alternative narratives: An integrative framework for understanding identity development in context. *Human Development*, 58(6), 318–349.
- Meyers, K. L., Ohland, M. W., Pawley, A. L., Silliman, S. E., & Smith, K. A. (2012). Factors relating to engineering identity. *Global Journal of Engineering Education*, 14(1), 119–131.
- Miles, M., & Huberman, M. (2014). *Qualitative data analysis: A methods sourcebook*. Sage Publications.
- Morrison, C., & Williams, L. (1993). Minority engineering programs: A case for institutional support. *NACME Research Newsletter*, 4(1), 1–13. Retrieved from <http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=ED372877>
- Moustakas, C. (1994). *Phenomenological research methods*. Sage Publications.
- National Academy of Engineering. (2002). *Diversity in engineering: Managing the workforce of the future*. The National Academies Press. <https://doi.org/10.17226/10377>
- National Academy of Engineering. (2019). *NAE grand challenges for engineering*. Retrieved from <http://www.engineeringchallenges.org/challenges/16091.aspx>
- National Academy of Engineering, & Committee on the Engineer of 2020 Phase I. (2004). *The engineer of 2020: Visions of engineering in the new century*. National Academy of Engineers.
- National Science Foundation, National Center for Science and Engineering Statistics. (2015). *Women, minorities, and persons with disabilities in science and engineering: 2015* (Special Report NSF 19-304). Retrieved from <http://www.nsf.gov/statistics/wmpd/>
- Obiomon, P. H., Tickles, V. C., Wowo, A. H., & Holland-Hunt, S. (2007). Advancement of women of color in science, technology, engineering, and math (STEM) disciplines. *Proceedings of the Advancing Women and the Underrepresented in the Academy Symposium*. Retrieved from <https://facultyresourcenetwork.org/publications/advancing-women-and-the-underrepresented-in-the-academy/advancement-of-women-of-color-in-science-technology-engineering-and-math-stem-disciplines/>
- Omi, M., & Winant, H. (1994). *Racial formation in the United States: From the 1960s to the 1990s* (2nd ed.). Routledge.
- Ong, M. (2005). Body projects of young women of color in physics: Intersections of gender, race, and science. *Social Problems*, 52(4), 593–617. <https://doi.org/10.1525/sp.2005.52.4.593>
- Perez, T., Cromley, J. G., & Kaplan, A. (2014). The role of identity development, values, and costs in college STEM retention. *Journal of Educational Psychology*, 106(1), 315–329. <https://doi.org/10.1037/a0034027>
- Pierrakos, O., Beam, T. K., Constantz, J., Johri, A., & Anderson, R. (2009). On the development of a professional identity: Engineering persistors vs. engineering switchers. *Proceedings of the Frontiers in Education Conference*. <https://doi.org/10.1109/FIE.2009.5350571>
- Powell, A. (2009). *The (un)balancing act: The impact of culture on women engineering students' gendered and professional identities*. Loughborough University.
- Revelo Alonso, R. (2015). *Engineering familia: The role of a professional organization in the development of engineering identities of Latina/o undergraduates*. University of Illinois at Urbana-Champaign. Retrieved from <http://hdl.handle.net/2142/78420>
- Rice, D. N. (2011). *The career experiences of African American female engineers*. Texas A&M.
- Riley, D. (2008). Engineering and social justice. In C. Baillie (Ed.), *Synthesis Lectures on Engineers, Technology, and Society* (pp. 47–106). Morgan & Claypool Publishers.
- Ross, M. (2016). *A unicorn's tale: Examining the experiences of Black women in engineering industry*. Purdue University.
- Ross, M., Capobianco, B., & Godwin, A. (2017). Repositioning race, gender, and role identity formation for Black women in engineering. *Journal of Women and Minorities in Science and Engineering*, 23(1), 37–52.
- Ross, M., & Godwin, A. (2015). WIP: Stories of Black women in engineering industry—Why they leave. *Proceedings of the Frontiers in Education Conference*. <https://doi.org/10.1109/FIE.2015.7344116>
- Ross, M., & Godwin, A. (2016). Engineering identity implications on the retention of Black women in engineering industry. *Proceedings of the 123rd ASEE Annual Conference & Exposition*.
- Ross, M. S., & McGrade, S. (2016). *An exploration into the impacts of the National Society of Black Engineers (NSBE) on student persistence*. American Society for Engineering Education.
- Smith, J. A. (2011). Evaluating the contribution of interpretive phenomenological analysis. *Health Psychology Review*, 5(1), 9–27.
- Smith, J. A., Flowers, P., & Larkin, M. (2009). *Interpretive phenomenological analysis: Theory, method, and research*. Sage Publications.
- Smith, T. W. (2007). Social identity and socio-demographic structure. *International Journal of Public Opinion Research*, 19(3), 380–390.
- Stryker, S., & Burke, P. J. (2000). The past, present, and future of an identity theory. *Social Psychology Quarterly*, 63(4), 284–297.
- Swanson, J. L., & Fouad, N. A. (2014). *Career theory and practice: Learning through case studies* (3rd ed.). SAGE Publications.
- Tajfel, H. (1981). *Human groups & social categories: Studies in social psychology*. Cambridge University Press.
- Tate, E. D., & Linn, M. C. (2005). How does identity shape the experiences of women of color engineering students? *Journal of Science Education and Technology*, 14(5–6), 483–493. <https://doi.org/10.1007/s10956-005-0223-1>
- Tonso, K. L. (1996). The impact of cultural norms on women. *Journal of Engineering Education*, 85(3), 217–225. <https://doi.org/10.1002/j.2168-9830.1996.tb00236.x/abstract>

- Tonso, K. L. (2006). Student engineers and engineer identity: Campus engineer identities as figured world. *Cultural Studies of Science Education*, 1(2), 273–307. <https://doi.org/10.1007/s11422-005-9009-2>
- Tracy, S. J., & Trethewey, A. (2005). Fracturing the real-self ↔ fake-self dichotomy: Moving toward “crystallized” organizational discourses and identities. *Communication Theory*, 15(2), 168–195.
- U.S. Census Bureau. (2014). *Population division*. Retrieved from <https://www.census.gov/data/tables/2014/demo/popproj/2014-summary-tables.html>
- van Hoof, A., & Raaijmakers, Q. A. (2003). The search for the structure of identity formation. *Identity: An International Journal of Theory and Research*, 3(3), 271–289.
- Walther, J., Sochacka, N. W., & Kellam, N. N. (2013). Quality in interpretive engineering education research: Reflections on an example study. *Journal of Engineering Education*, 102(4), 626–659.
- White House. (2013). *Educate to innovate*. Retrieved from <https://www.whitehouse.gov/issues/education/k-12/educate-innovate>
- Yoder, B. L. (2014). *Engineering by the numbers*. Retrieved from <https://www.asee.org/papers-and-publications/publications/college-profiles/14EngineeringbytheNumbersPart1.pdf>

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