



Exploring the Enterprise Knowledge of Black Males in Undergraduate Engineering Programs

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ABSTRACT

Background: Though the relationship between engineering and commercial enterprise has been documented for well over the last century, there is little research that addresses how students, and specifically Black males, make meaning of this relationship.

Purpose/Hypothesis: In this study, we explored interview data from 20 Black male engineering students from across the United States to understand how they construct enterprise related knowledge.

Design/Method: As a product of an overarching Interpretative Phenomenological Analysis project, this study involved secondary analysis of interview data. After conducting three stages (descriptive, linguistic, and conceptual) of analysis, two themes were constructed.

Results: The findings consisted of two knowledge constructs that were developed from participants' accounts. The *Educational Construct* defined how participants described enterprise related learning and the *Economic Construct* demonstrated participants' knowledge of the economic enterprise of engineering.

Conclusions: These findings demonstrate participants' ability to develop meaningful educational and economic constructs, and they showcase Black males in engineering education as assets to the field. Implications of this study include opportunities for undergraduate engineering students to gain and apply formal enterprise knowledge and future research which primarily and intentionally assesses the process and product of engineering students' construction of enterprise-related knowledge.

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BACKGROUND

Although Kanye West is credited as the lead performer on the smash hit, *Diamonds* from *Sierra Leone*, it was Jay Z's feature that left rap fans dumbfounded. In a show of elite lyricism, Jay-Z highlighted his unmatched commercial success by announcing his transcendence from "a businessman" to a "business ... man." These lyrics represent a pertinent point of reference for the development of our project, having provided a conceptual anchor for the primary phenomenon of the study. The cognitive activity embedded in the development and delivery of this pun evinces what we consequently termed *the construction of enterprise knowledge*. We used the term *enterprise knowledge* to encompass various commercial activities related to entrepreneurship, business, management, economics, and innovation.

Our work in this article originated from an overarching study intended to understand the experiences and aspirations of Black male undergraduate engineering students (Henderson et al. 2022a). What unfolded, however, was our analysis of an unanticipated social phenomenon of interest (Collins & Stockton 2018; Timmermans & Tavory 2012). While conducting analysis for the overarching interpretative phenomenological analysis study, we identified repeated references to business, entrepreneurship, and economics that prompted deeper analysis. To that end, we engaged in secondary analysis that aimed to understand this phenomenon in greater detail.

ENTERPRISE AND ENGINEERING

The relationship between enterprise and the education and profession of engineers has been documented for well over a century. As far back as 1917, there is record of Hayford (1917) extolling the pertinent "relation of engineering to economics" (p. 59). The outcomes of this relationship have produced a long history of US economic dominance, notably linked to substantial market shares in product design, manufacturing innovation, and process engineering (Mendelson 1999; National Research Council 1991). Over this time, the engineering profession has undergone significant changes. Engineers of today must demonstrate more creativity, be able to identify innovation opportunities, and synthesize data to solve novel problems (João & Silva 2020). These skills are often associated with production goals of larger firms, which gives credence to the claim that US engineering education originated to secure America's "corporate and economic interests" (Katz & Main 2022, p. 34). In the current economy, there is growing emphasis across organizations of all sizes—not just largescale corporations—to be innovative, creative, and competitive (Galama & Hosek, 2007; Galloway et al. 2006). To maintain a competitive edge, organizations must acknowledge the socio-cultural dimensions of engineering by identifying and responding to customers' unique needs (Grimson & Murphy 2015; Mark 2018; Nieusma 2011). Thus, it is not only the technical aspects of engineering that underscore the relationship between enterprise and engineering but also the social, political, and economic context of the field (Grimson & Murphy 2015; Mark 2018; Nieusma 2011).

Since the engineering-enterprise relationship is multi-dimensional, several intellectual pathways can lead to a better understanding of the concept. Notably, Katz and Main (2022) acknowledge that the earlier scholarship in this area has either covered the topic infrequently, causing temporal gaps or generically providing limited nuance. In this paper, we aim to address these gaps by foregrounding the often unrepresented and noticeably absent voices of Black male engineering students (Henderson et al. 2022b; Holly 2020; Moore et al. 2003; Sellers et al. 2022). To do so, we aim to examine participants' construction of enterprise knowledge from their meaning making of the undergraduate engineering experiences they shared. The production of engineering-based educational research that centers Black men is crucial; these studies are pertinent to negating and counteracting the perennial underestimation of Black male contributions to the field of engineering (Burt 2020; Sellers et al. 2022). Given that our study intentionally illustrates and promotes participants' knowledge construction, this work counters the deficit narrative that has historically characterized Black males in engineering (Holly 2021b). Additionally, it demonstrates a non-performative and asset-based empirical approach for understanding the realities of a traditionally marginalized, non-dominant demographic group (Harper 2010; Martin & Wendell 2021; Sellers et al. 2022).

LITERATURE REVIEW

Engineering education, inclusive of on-the-job training, prepares students to be planners, builders, managers, decision-makers and, most notably, problem solvers. Not only do these titles require mastery of traditional engineering competencies, but they also demand appropriate stewardship of human, physical, societal, and financial resources (Riggs & West 1986; Sullivan 1991; Sullivan et al. 2015). Engineers must therefore merge their technical and enterprise knowledge to ensure that consumer needs are met. To foreground our understanding of the enterprise knowledge that Black male engineering students construct, we examined a subset of current literature addressing:

1. the nexus between enterprise and engineering education and
2. the experiences of Black male students in undergraduate engineering programs.

By responding to the research question: “How do Black male engineering students construct and contextualize enterprise knowledge?” it is hoped that this study will highlight a critical intersection between these two areas of scholarship.

THE ROLE OF ENTERPRISE IN ENGINEERING EDUCATION

Engineers of today are required to understand and perform within “the context of market and business pressures” (Byers et al. 2013, p. 36). Observations such as these precede the last century of engineering education literature (Hayford 1917) and possibly underscore the expanded presence of enterprise related subject matter across engineering curricula and research.

The majority of enterprise-related engineering education research examines topics related to entrepreneurship. These studies have examined entrepreneurial habits of the mind such as students’ perception, mindset, intent, and motivation (Borchers & Park 2010; Bosman et al. 2019; Duval-Couetil et al. 2014; João & Silva 2018; João & Silva 2020); current knowledge gaps in entrepreneurial education (Shartrand et al. 2015); entrepreneurial outcomes for students (Duval-Couetil et al. 2016; Galloway et al. 2006; Ohland et al. 2004); models of entrepreneurial education (Duval-Couetil et al. 2010; Reid & Ferguson 2011; Standish-Kuon & Rice 2002), as well as entrepreneurial engineering identity (Edwards & Pillapakkam 2018; Har-el et al. 2021). Outside of the entrepreneurial realm, there is also a subset of literature that situates broader enterprise topics, such as business and economic theories (Chelsom et al. 2005; Hayford 1917; Katz & Main 2022; Richardson 1997) and industry perspectives (Black 1994; Coşkun et al. 2019; McMasters 2004; Oprean et al. 2010) within the field of engineering education. While still in its emergent phase, this area of literature has focused on majority demographic groups with little emphasis placed on Black males. Limited coverage of Black males and their experiences and perspectives is not anomalous; rather, it trends the overarching body of engineering education research.

BLACK MALES IN UNDERGRADUATE ENGINEERING EDUCATION

We are unwaveringly critical of the substantive body of engineering education research that investigates the experiences of Black males. The majority of this research characterizes Black males as arbitrarily underprepared, possessing lesser interest, and showcasing sub-par academic performance in engineering (Harper 2010; Holly 2021b; Holly & Quigley 2022; Martin & Wendell 2021; Sellers et al. 2022). Holly and Quigley are, therefore, justified in highlighting America’s contempt for African descendants in—or on the path towards—engineering professions (Latham 2018; Wharton 1992). Much like Mejia et al. (2020), Holly and Quigley also expose the White patriarchal imperialist culture within the academic and professional fields of engineering. In doing so, they call out how these ideologies converge to ultimately exclude those who do not share the previously mentioned identities.

These inequities undoubtedly undergird reports that highlight the disproportionately low 3% of undergraduate engineering degrees awarded to Black men (American Society for Engineering Education 2019). The legacy of Historically Black Colleges and Universities (HBCUs) is yet another telling reality. HBCUs, while often credited for the “heavy lifting” involved in increasing the US

supply of Black male engineers, face severe underfunding by federal agencies (Holly & Quigley 2022). As a result, Black male engineering graduates tend to amass significantly larger amounts of student debt than their non-Black peers (Beal et al. 2019; Holly & Quigley 2022).

McGee (2016) and Sellers et al. (2022) both emphasize how this student demographic faces continued stereotyping and exclusionary program cultures that often treat White males as normative and exclude all other populations. Similarly, Holly and Quigley (2022) highlight challenges with tokenism and educational discrimination, but notwithstanding such documented turmoil, the resilience and cultural capital of this ethno-gender continues to inspire an expanding body of critical literature that presents their experiences through an asset-focused frame (Harper 2010; Martin & Wendell 2021; Sellers et al. 2022; Yosso 2005). Recent anti-deficit research frameworks have rejected arbitrary references to the “undeterred will” of Black male engineering students. Instead, newer perspectives situate the discussion about Black students and their resilience within the context of academic performance. Such an approach highlights the nexus between determination and academic achievement in historically challenging courses such as “statics, dynamics, and the like” (Holly 2021a, p. 49). These approaches replace the individualistic tropes that have traditionally characterized the limited presence of Black males in engineering education with narratives of systemic racism and opportunity gaps (Henderson et al. 2022a; Holly 2020; Moore et al. 2003; Sellers et al. 2022; Tolbert Smith 2022). Critical perspectives such as these provide a pathway for non-performative improvements in engineering education research (Holly & Quigley 2022) and the educational experiences of future Black engineers (Slaughter et al. 2015). Notwithstanding the plausibility of these scholarly claims, a healthy measure of skepticism must be maintained until gatekeepers and power wielding stakeholders fully eliminate the anti-blackness that pervades the current engineering pathway (Holly & Quigley 2022).

PURPOSE

Based on our literature review, we were inspired to answer calls by Katz and Main (2022), Tolbert Smith (2022), and Holly and Quigley (2022) to conduct proactive, asset-based research that:

- demonstrates appreciation for Black male engineering knowledge construction,
- increases positive representation of Black people in engineering education research, and
- illuminates the relationship between enterprise and engineering.

Our study provides an integrated response to these research recommendations by examining the enterprise-related knowledge construction of Black male engineering students, a key significance of which is the refinement of pervasive conventions (Walther et al. 2013) about Black males reported in engineering education research (Henderson et al. 2022a; Holly 2020; Moore et al. 2003; Sellers et al. 2022).

THEORETICAL FOUNDATION

A nexus of three elements comprises the theoretical foundation on which this study stands. These theoretical elements included: (a) the song lyrics previously referenced, (b) existing literature, and (c) a constructivist epistemological lens.

Jay Z’s lyrics provided our initial theoretical frame. The metaphoric play on the words “business” and “man” allowed us to achieve conceptual consensus; as we all agreed that the rapper’s phrasing had demonstrated effective construction and articulation of enterprise knowledge. This observation provided the anchor for what we intended to research and gave us a parking lot to return to in times of interpretative disagreement. Additionally, the sample was recruited from the National Society of Black Engineers population, an organization that offers *personal branding* career development opportunities for Black engineers. It could therefore be said that the lyrics keenly aligned with an ethos or sentiment familiar to the participants.

As the study progressed, we later employed the theorization of Ignelzi (2000), who applied meaning-making theory (Kegan 1980) to the field of education. Ignelzi's blueprint framed our data analysis around participants' (a) learning experiences, (b) knowledge constructs, (c) relationships, and (d) sense of self (Ignelzi, 2000). For analysis, we examined participants' responses to identify and understand *learning experiences* which included reflections or comments about participants' educational aspirations, experiences during classes, choice of coursework and their cocurricular engagements; *knowledge constructs* in instances where participants created and demonstrated a cogent understanding of an issue that was associated with the learning experiences previously mentioned; *relationships* which focused on participants' interactions with key stakeholders in their educational journey, such as professors, teachers, guidance counselors, role models, and peers; and finally *sense of self* that encompassed participants' beliefs about themselves and their identity as individuals. Overall, Ignelzi's work could be viewed as four conceptual buckets which structured our analysis of individual transcripts.

Having prioritized participants' knowledge construction as the key social reality under investigation, we decided that a constructivist paradigm would provide the final component of our theoretical frame. Through this philosophical lens, we were able to observe empirical patterns that illustrated participants' construction of enterprise knowledge. The philosophical lens provided a frame for us to form coherent constructs from participants' perspectives, values, and beliefs about their engineering education experience (Kolari & Savander-Ranne 2000).

The convergence of these three theoretical elements allowed us to identify complexities in participants' meaning making while also constructing coherence across their individual cases (Walther et al. 2013). This theoretical foundation provided an anchor for our interpretations, which ultimately prevented us from "drowning" in data (Collins & Stockton 2018; Morse 1993) or experiencing "analysis paralysis" (Huffman & Tracy 2018, p. 563).

METHOD

Unlike the structured methodology performed during our original Interpretative Phenomenological Analysis, this secondary study involved an exploratory style of qualitative inquiry (Caelli et al. 2003). Rather than adhering to strict methodological canons, we followed a continually unfolding path which led us to understand participants' meaning making (Gibson & Hartman 2013; Kegan 1980).

ETHICAL AND QUALITY CONSIDERATIONS

Ethics of trustworthiness and goodwill informed our research procedures (Walther et al. 2013). To ensure the integrity of the project, the study design underwent the Institutional Review Board (IRB) approval process at [institution redacted] and the research team also received participants' informed consent before commencement of data collection. Favorable intentions for participants and their lives undergirded our motivation for this study (Walther et al. 2013). We therefore approached this work with the goal of illuminating the knowledge assets they possessed. To develop the style of co-constructed findings that Bhattacharya (2017) described, we tried as much as possible to retain the conventions of participants' language choices. This decision led us to continually survey our analysis to limit the influence of our preconceptions on the development of this manuscript (Walther et al. 2013).

DATA COLLECTION PROCEDURES

An IRB-approved recruitment email was distributed to National Society of Black Engineers (NSBE) secretaries and presidents from across the United States. These officials were asked to distribute the invite to their respective chapter members. In addition, the communications team at the NSBE Headquarters also disseminated an email blast to all members. Snowball sampling was also found to be beneficial, given the known underrepresentation of the participant group of interest (Nizza et al. 2021). Before the interview, participants completed an online demographic form that requested information on their personal and academic backgrounds. Each participant was allowed to select a pseudonym of their choice. To maintain consistency and trustworthiness across

interview sessions, two specific team members either individually or collaboratively conducted all semi-structured interviews. An excerpt of the interview protocol is appended to showcase the key questions from which the majority of data was collected. Consistent with established qualitative procedures, interviews were recorded and transcribed by an external transcription service. Minor transcription errors were then corrected by project team members (Nizza et al. 2021).

PARTICIPANTS

The study sample consisted of 20 Black male undergraduate engineering students. Table 1 provides a profile outlining participants' year classification, engineering discipline, institutional type, and self-selected pseudonym.

Table 1 Participant Profile.

PSEUDONYM	CLASSIFICATION	ENGINEERING MAJOR(S)	INSTITUTION TYPE
Billy	Junior	Mechanical	PWI
Carl	Junior	Electrical	PWI
Christopher	Sophomore	Mechanical	HSI
Corbin	Senior	Electrical & Computer	HSI
Dave	Junior	Industrial	HSI
Ed	Junior	Chemical	PWI
Jack	Sophomore	Mechanical	HBCU
Jalen	Senior	Mechanical	PWI
Jay	Junior	Computer	PWI
Jefferson	Junior	Computer	PWI
Joe	Senior	Mechanical	PWI
John Edward	Senior	Civil	PWI
Jonail	Senior	Mechanical	PWI
Josh	Junior	Mechanical	PWI
Matthew	Senior	Civil	PWI
Oman	Senior	Chemical	PWI
Omarion	Junior	Civil	PWI
Peter	Senior	Chemical	PWI
Plato	Freshman	Chemical	HSI
Quinton	Senior	Mechanical	PWI

RESEARCHERS' POSITIONALITIES

Research is a manifestation of researcher positionality (Hampton et al. 2021; Secules et al. 2021). Having examined the influence of our positionalities on this study, we identified our social identities, professional experiences, and life trajectories as key elements of its development. Consequently, we recognize—and appreciate—the impact of these life components across “every phase” of this project (Hampton et al. 2021, p. 126).

Racially, both authors identify as Black: the first as an Afro-Caribbean immigrant woman and the second as an African American man. We have spent a considerable amount of professional time in education—a tenure that has spanned the K–20 space with a keen focus on the experiences of marginalized learners. Additionally, we view this project through the lens of our first-generation college graduate status and wish to highlight that although we represent a minoritized racial group, we neither consider ourselves as academically neglected nor underserved.

The conceptualization of this study resonates primarily with the subjectivities of the first author. In particular, the selection of the social reality under investigation and the approach to analysis are highly reflective of her appreciation for contemporary Black (music and vernacular) culture and her social science disciplinary training.

DATA ANALYSIS

Although our research design escaped the *chokehold* of any singular convention or tradition, our data analysis mirrors elements of Interpretative Phenomenological Analysis (Nizza et al. 2021). Overall, our analytical procedures were predominantly guided by the compelling narratives that unfolded as we proceeded (Nizza et al. 2021).

We should highlight that our analytical procedures started during descriptive transcript annotation, that is, the first stage of analysis, for the primary study (Nizza et al. 2021). During this relatively open stage of coding, where the aim is to familiarize oneself with the available data (Saldaña & Omasta 2018), we noticed repeated references to enterprise related matters embedded in participants' responses. This pattern piqued our scholarly interests and directed our aims in the subsequent stages of analysis.

We approached the second stage of analysis, and secondary coding, with the goal of examining participants' language and their knowledge construction related to enterprise and enterprise related matters (Saldaña & Omasta 2018). Existing theories of meaning making supported our analysis. We used these insights to identify patterns related to participants' (a) learning experiences, (b) knowledge constructs, (c) relationships, and (d) sense of self (Ignelzi 2000; Kegan 1980). The frame provided by Ignelzi and Kegan scaffolded our development of linguistic and conceptual comments, which formed the basis of the themes in this study (Nizza et al. 2021).

After completing primary and secondary coding, both authors reconvened to compare our notes and interpretations of participants' accounts. A long-table exercise was conducted that involved hand recording participant quotes on strips of paper and physically arranging them to develop a coherent conversation between participants' accounts (Nizza et al. 2021). During this exercise, conceptual questions were posed which ensured that the narratives developed were accurate and mutually agreed upon (Bhattacharya 2017). After confirming that our interpretations reflected the complexities of the data set, we paused explicit data analysis (Bhattacharya 2017; Walther et al. 2013) to begin report writing and finalized minor inconsistencies thereafter.

FINDINGS

The aim of understanding how Black male engineering students construct and conceptualize enterprise knowledge led to the production of two findings in the form of knowledge constructs. The first was the *Educational Construct*, defining how participants described their own enterprise related learning. The *Economic Construct*, the second product of our analysis, demonstrates participants' knowledge about the larger economic enterprise of engineering.

EDUCATIONAL CONSTRUCT: CHARACTERIZING ENTERPRISE-RELATED LEARNING

Participants presented a variety of narratives that demonstrated cogent thinking about enterprise-related learning. Enterprise learning included a series of educational pursuits that provided participants with exposure to entrepreneurship, business, management, economics, and innovation knowledge. Specifically, the participants highlighted outcomes, time periods, and sources of enterprise related learning experiences, and through analysis of their accounts, we identified how participants' desired outcomes influenced their choices for the format and timing of their enterprise-related learning.

Outcomes of enterprise learning

The first sub-theme, *Outcomes of enterprise learning*, reflected participants' meaning making around the knowledge and skill development associated with enterprise-related learning.

Participants demonstrated how this education could facilitate skill development and career advancement. One participant extolled the educational value, stating:

The reason why I've chosen [my industrial engineering degree with a minor in economics] is because I believe I would get the best from engineering, from knowing the basic engineering concepts... Also, with a minor in economics, it would help me with numbers and how the basic business works, like opportunity cost and all that. (Dave, Junior, Industrial Major)

Another participant who intends to pursue an MBA program specializing in entrepreneurship anticipated gaining the skills needed for patenting and selling ideas. Similarly, another participant with aspirations for an MBA degree, described “opportunities for promotions and better job positions and salary” as his “driving force” for earning the degree, with yet another viewing his aspiration for “a master’s degree in business” as an opportunity to become more acquainted with business concepts that would allow him to build managerial skills and be able “to lead from the front of the pack [and] reach the very, very top” of an organization. This outlook was also shared by the participant pursuing the industrial engineering degree—which he likened to “management engineering.” He proffered that the industrial focus of his program endowed him with the skills needed to make a “positive impact” on the “careers and ... engineering” practices of a “younger set of engineers.” He was adamant that the management focus of his coursework diametrically opposed “other engineering [disciplines], like chemical engineering and civil engineering” which, he opined, monotonously did “the same thing over and over.”

A deeper interpretation of this subtheme also considered the alignment between the outcomes of enterprise learning and the Jay Z lyrics which informed the direction of this study. In the song, Jay Z announces his transcendence from a businessman to a business ... man and this distinction can also be seen in participants’ meaning making. While some participants highlighted their outcomes in relation to their careers in external entities, for example, “opportunities for promotions and better job positions and salary,” others saw the benefit of their enterprise learning as facilitating intrapersonal development and augmenting their personal value: “with my MBA, I’m making sure to have a concentration on entrepreneurship. So hopefully ... patenting idea[s].”

Timing of enterprise learning

As the research team continued to examine participants’ interest in enterprise-related education, we noticed differences in the timing of their educational pursuits. In particular, we observed that their desire to engage with enterprise learning varied across current and future time periods. As a result, some participants referenced learning experiences that were in progress at the time of their interview, while others referred to this learning as an imminent goal. Examples of the former could be found in a participant stating, “I am currently studying to get my industrial engineering degree with a minor in economics” and another highlighting that he had already completed a “couple of economic classes” to complete his engineering degree. Conversely, however, most participants expressed their interest in enterprise learning within the context of a future educational goal, for example, “I know I could be able to get an MBA ... then I can use that to help advance me in my engineering or business career.” Another participant, sharing similar sentiments, stated, “after I get my undergraduates ... this semester, I plan to get an MBA.”

The temporal difference between present and future enterprise learning tells a notable tale. It illustrates the opportunities which exist for engineers-in-training to acquire formal enterprise knowledge across the baccalaureate and post-baccalaureates stages of education. The distinction can also reflect differences in timelines for workforce entry. It is likely that some may pursue such learning during their undergraduate program so as not to delay employment, while others may delay employment in favor of advanced academic training. Both pathways present relative advantages and disadvantages, and this reality was highlighted by a participant contrasting further education versus immediate workforce entry via the following considerations:

[the decision] has to do with how much money I'm getting at this point since I'm going to graduate; that has to do with how much the school's going to give me. Do I possibly have a fellowship ... or something? Whereas for a job, it depends on how close to home it is and how much they're paying me in terms of other jobs I've applied to. (Oman, Senior, Chemical Major)

Sources of enterprise learning

We also opine that participants' preference for either undergraduate or graduate-level enterprise education may reflect the varying depths of knowledge that they perceive as necessary for their individual career goals. For instance, while some participants described only being "interested in the basic[s]" of how businesses work or wanting to know "a little bit about a lot" of things related to an organization, others sought more complex understanding of matters related to business law, for example patenting, and concepts of business economics such as organizational structure and operations (Galende 2006; Sager et al. 2006).

Given our attention to participants' linguistic choices, the research team surmised that while participants presented varying academic paths for acquiring enterprise knowledge, it was Master of Business Administration (MBA) programs which emerged as the premier source and choice. The development of the *Sources of enterprise learning* subtheme originated from our identification of participants frequent and explicit references to the MBA qualification as their preferred route for entrepreneurial and business education. There were multiple instances where participants expressed definite intentions for their pursuit of an MBA degree. Examples included: "after I get my undergraduates at the end of this semester, I plan to get an MBA" or "I'm looking at what schools I want to go [for] my master's because ... I know I want to get my MBA." Another participant, speculating on the future aspirations of his social circle, explained that for his "peers and those pursuing graduate degree, it's really just been MBAs."

There were other participants who highlighted alternatives such as undergraduate coursework in economics or professional certifications but participants' knowledge construction around enterprise-related learning prioritized the MBA degree. The popularity of the MBA inherent in participants' meaning making could easily be attributed to the common association of MBA degrees with professional seniority and advancement in engineering settings (e.g., plants and firms). One participant alluded to this sentiment, recalling that "a lot of people" had advised him to "wait [to pursue] an MBA," since most people who pursued MBAs had generally "worked for a couple of years," and had amassed "a little bit more experience" before embarking upon this academic route. The prevalent interest in the MBA degree was found to be even more telling, given the existence and availability of several interdisciplinary advanced degrees which integrate engineering and business disciplines. Examples of such programs include the Master of Science in Engineering Management and the Master of Science in Engineering and Production Management (Mendelson 1999; Sager et al. 2006). Except for two participants, one who likened his degree to "managerial engineering," and another whose undergraduate degree plan included an economics course, there were no other instances where participants expressed interest in an interdisciplinary program option.

ECONOMIC CONSTRUCT: THE ECONOMICS OF ENGINEERING AND ITS ROLE IN THE WIDER ECONOMY

Given the constantly evolving nexus between engineering, innovation, and economy, contemporary engineers are responsible for harnessing skills which exceed technical know-how. Similarly, participants' meaning making demonstrated a collective understanding of economic constructs within the engineering business enterprise. While the educational construct identifies the ways in which participants constructed both the outcomes of and the paths to enterprise learning, the economic construct illustrates how they identified the relationship between engineering and enterprise concepts with reference to the broader profession or field of study. Participants articulated these constructs across varying degrees of abstraction; while some made explicit references to economic terminology, others implicitly alluded to their economic understandings. Examples of the former, included one participant who commented,

I'm actually Nigerian. In that part of the world and those third-world countries, we, most times, import things from foreign countries. We don't make things locally, so I feel like ... I want to be a person who makes things and not get things from other countries. I want to start up my own manufacturing company back at home, so it will help the economy. (Dave, Junior, Industrial Major)

And another declared:

I have an interest in oil and gas, but I also have a fear of that because I feel like with oil and gas, it's unstable because it's really dependent on the price of oil, which does tend to fluctuate, and that's my fear. I don't know if that's a reasonable fear because I just don't feel like—I'm afraid of putting my job, like tying my job to the price of a commodity. (Plato, 1st Year, Chemical)

Others shared aspirations such as, "hopefully, I can patent that idea, I can sell it off and sell out." Similarly, another participant acknowledged that his economics degree minor would aid in his understanding of "how the basic business works, like opportunity cost and all that."

These references to *import economies*, *volatility of oil prices*, *patents* and *opportunity cost* explicitly demonstrate participants' development of economic knowledge constructs which they have appropriately contextualized within their engineering realities. Conversely, other participants alluded to economic constructs indirectly. Examples of such allusions can be observed across the following participant quotes:

going to graduate school has to do with how much money I'm getting since I'm going to graduate; that has to do with how much the school's going to give me. Do I possibly have a fellowship ... or something? Whereas for a job, it depends on how close to home it is and how much they're paying me. (Oman Senior, Chemical)

If I want to get a master's, I'd work for a year to get my company to pay for it and graduate in like two years, continue working for that company for maybe a year or more, or two years more, because they want you to stay after spending so much money on you. (Jonail, Senior, Mechanical)

Inherent in the first quote is the participant's understanding of economic concepts such as opportunity cost and cost-benefit analysis. The second quote, on the other hand, reflects the participant's application of return-on-investment analysis.

Additionally, evidence of the economic concept, human capital development also became apparent. Throughout their meaning-making, participants addressed the relationship between the skills they intended to develop over time and their value within future industries. As participants envisioned their imminent careers, the references to human capital development became more noticeable. As one stated,

like I was saying, industrial engineering is more long-term in the sense that, I feel like after I gained the required skills, I needed to elevate myself or to satisfy my knowledge—10 years down the line, 15–20 years down the line, I'll be able to manage the younger set of engineers. (Dave, Junior, Mechanical)

Comparable meaning-making was also observed when another participant recognized that by getting a job, earning a master's degree, and having "worked for 10 years," he would increase his value "to the working world, to industry, to companies, to the government, and stuff like that."

These varied accounts demonstrate participants' knowledge of economic constructs, particularly within the subspecialty of business economics. Their ability to situate these insights within the context of the engineering industry and the wider economy is telling as it demonstrates advanced application and synthesis skills.

Historically, scholarship on Black male engineering students has consisted of deficit-ridden tropes (Holly 2021a). In response, recent contributions have deliberately foregrounded the various assets belonging to this population (Harper 2010; Martin & Wendell 2021; Sellers et al. 2022; Tolbert Smith 2022). Alongside the Black male engineering scholarship, there is also a separate but complementary body of research that references the importance of business and economic acumen in engineering (Chelsom et al. 2005; Grimson & Murphy 2015; Hayford 1917; Katz & Main 2022; Richardson 1997). Our work in this present article synergizes both lines of inquiry by demonstrating how Black male engineering students construct and contextualize enterprise knowledge. The insights gleaned are beneficial to the wider engineering ecosystem since failing engineering industries are often characterized by misaligned market needs and principles (Adriaens & Faley 2008; Galloway et al. 2006).

Participants' interest in enterprise-related education proved multifaceted. Some elements converged with published literature while others deviated. For instance, the findings opposed a review of literature on inner-city Black male youths that Jennings (2014, p. 840) conducted, in which "the most common finding was that youth did not have initial business interests or knowledge." Participants in our study challenge Jennings' assertion with their overwhelming interest and knowledge of enterprise-related matters.

These findings aligned more closely with Gilmartin et al. (2019) and their perspectives on the (a) innovation orientation engineering majors possess and (b) the positive relationship between male engineering students and interest in enterprise-related learning. Though the alignment is apparent, it is important to note that Gilmartin et al. employed a heterogeneous sample, comprising less than 13% Black students. Our findings, though qualitatively grounded in the Black male experience, seem to parallel the majority student population that Gilmartin et al. investigated, leading us to contend that although dominant literature has characterized Black males in engineering as academically subpar (Harper 2010; Holly 2021b; Holly & Quigley 2022; Martin & Wendell 2021; Sellers et al. 2022) and generally uninterested in business (Jennings 2014), the experiences of these participants suggest differently.

Another novelty of the study is reflected in the experience of participant Dave (Junior, Industrial Major) who explored the relationship between his nationality and future enterprise aspirations. Such an observation is concurrent with Smith (2011), who acknowledged that a single, unique occurrence may shed beneficial light on a hidden phenomenon of import. Our findings align with Gilmartin and colleagues (2019), who asserted that students possess individual characteristics that can be linked to their academic and social identities. As a result, we see future engineers as products of the social identities they hold and their experiences within the wider society. One such example could be seen in how participant Dave recounted the myriad ways in which the economy of his African birth country had influenced the type of engineering role to which he aspires. The deeply contextualized ambitions that this participant shared align with the views of Mendelson (1999), who has noted that engineering students possess varied career goals that may be influenced by broader issues such as global economies. In addition to shaping the aspirations of future engineers like Dave, these broad perspectives also aid students in gaining engineering inspiration and in understanding the "ultimate purpose" of the field and "its proper relation to other [economic] activities" (Hayford 1917, p. 59).

By articulating the importance of enterprise-related learning in their future engineering role and function, we perceive participants as having demonstrated strategic thinking. Participants illustrated keen problem-solving capabilities through their ability to intentionally select and sequence the path of enterprise-related learning that adequately met their professional needs. Their competence in this area is consistent with decades of research that have characterized such a "valuable habit of thinking" (Hayford 1917, p. 59) as fundamental to an effective engineering workforce (Gilmartin et al. 2019; Mendelson 1999; Riggs & West 1986; Sullivan 1991). Added to the workforce perspective, and with a view towards organizational performance, Galloway et al. (2006) have described these skills as crucial for "reacting quickly to market changes" (p. 356).

With such responsiveness and flexibility characterizing the economy of today, we see participants' articulated interest in understanding "how businesses work" as an antecedent to developing the type of human capital that drives sustainable profit and economic growth (Galloway et al. 2006; Gilmartin et al. 2019; Grimson & Murphy 2015).

The conceptual value of this study also warrants mention. In particular, the focus on enterprise that characterizes the research phenomenon and study. As an umbrella categorization encompassing entrepreneurship, business, economics, management, and/or innovation, we find the term enterprise to be of conceptual benefit to engineering as well as other disciplines. Though there are nuanced differences between the individual concepts mentioned, these terms are often discussed in relation to, and sometimes even in place of, each other in engineering literature (Huang-Saad et al. 2020). In the case of *entrepreneurship*, in particular, there is limited agreement on the definition of the term (London et al. 2018). Recent definitions of entrepreneurship have even encompassed the actions of employees who advance and innovate within existing business organizations. This conceptualization contrasts the more traditional understanding which describes the act of creating and/or building a new business entity of one's own (Blake Hylton et al. 2020; Kriewall & Mekemson 2010). Our findings, much like Kriewall and Mekemson and Blake Hylton et al., demonstrate the contribution of engineers to both forms of entrepreneurship. Insights such as these illuminate the complex relationship between engineering, innovation advancement, and the economy (Blake Hylton et al. 2020; Kriewall & Mekemson 2010). We, therefore, encourage the use of the overarching term, enterprise, in place of entrepreneurship, since it encapsulates various interpretations of entrepreneurship along with other related concepts such as economics, business, management, and/or innovation.

When enterprise is used as an adjective to characterize engineering learning and/or knowledge, it illuminates the commercial context in which engineering is situated. The educational and economic constructs which resulted from this study provide the basis for our consideration of the term *enterprise episteme*. As we conceptualize it, enterprise episteme describes the commercial knowledge that is relevant to engineering education and practice. By including concepts such as these within current discourses in the engineering education community, it broadens the knowledge base of the field (Grimson & Murphy 2015; Mark 2018; Nieusma 2011). As understood from Grimson and Murphy (2015, p. 166):

Economics and business are important not only for the sake of understanding how business and commerce work on a national and global scale but also because engineers are likely to move into senior management positions at a later stage in their careers. Younger engineers are also attracted into finance where the coupling of mathematics with a judgment of what makes sense (allegedly a characteristic of engineers) is a prized asset.

This epistemological position coincides with the premise of our findings and exemplifies the role of enterprise episteme in engineering. Participants' interest in understanding how businesses and economies work signifies an urgent need to modify the current knowledge structure of engineering curriculum through greater multidisciplinary (Grimson & Murphy 2015, p. 177).

It is pertinent to acknowledge the temporal relevance of participants' knowledge construction. Their enterprise insights were appropriately situated within contemporary socio-economic context. We posit that any alterations to the epistemological structure of engineering should include enterprise episteme or knowledge insights which are timely and therefore suitable for conceiving of present and future engineering realities much in the same way that participants did. Like Mariotti (2021), we assert that Artificial Intelligence (AI) is an appropriate area for understanding the value of contemporary enterprise knowledge in engineering education and practice. The existence of AI in everyday devices and its commercial profitability justify the need for up-to-date enterprise learning. By up to date, we mean curricula that are not only timely but more so responsive to the needs of the broadest cross section of society. Scholars examining the intersection of race and technology often contend that technoscientific advancements primarily address the needs of majority social groups (Benjamin 2019). The areas of concern and interest highlighted by participants can serve as feelers for updating course scope, content, and sequence

to mitigate the creation of “biased bots,” camouflaged as “altruistic algorithm” (Benjamin 2019, p. 17). Participants’ knowledge construction provides the type of thinking needed to challenge normative engineering practices that primarily privilege whiteness.

IMPLICATIONS

These findings are not intended to exist within a vacuum or glass case; rather, it is their practical and theoretical applications which are of importance. To demonstrate the transition of these findings into implications, we outline their value in facilitating engineering program improvement, enhanced support for engineering students, and future lines of engineering education research.

Since these findings clearly demonstrate that Black male engineering students are producers of enterprise knowledge, we see value in modifying engineering programs to ensure that learning reflects and integrates student knowledge and experience. This can involve assessing students’ knowledge of various enterprise related concepts and creating opportunities for advancing this knowledge through class activities. Along this same line, we also foresee the benefit of designing bachelors-level MBA style workshops and/or seminars for students seeking additional enterprise-related education. There are also opportunities for offering BS-MBA combination programs which merge the completion of an undergraduate engineering degree with an MBA qualification. Upon completion, the graduate would be conferred with a bachelor’s degree in engineering along with an MBA degree. These program options will provide students with skills and strategies for operating successful commercial enterprises, either owned by employers or themselves. Skills like these are pertinent since research has shown that several engineering aligned businesses fail due to limited knowledge of market structures and industry context.

With findings also suggesting that finances are only one part of students’ career motivation, we envision prospects for career and academic advisors to tailor services to a broader spectrum of career aspirations and inspirations. These multifaceted interests may be an untapped opportunity in the recruitment and retention of Black male students in the high attrition field that is engineering. Student and academic affairs professionals may elect to integrate students’ interests and motivators into the sequence of their degree plans, ensuring that students are aware of opportunities for learning within a more culturally responsive context. Added to which, professors can embed multiculturalism into curricula with the aim of transforming engineering into a more culturally sustaining and humanistic discipline.

Participants shared a wide breadth of insights from which engineering and engineering education communities can draw knowledge. The value of their stories is epistemologically relevant since, at the core, engineering involves solving problems based on accurate selection and utilization of knowledge (Grimson & Murphy 2015). Given the knowledge that these future engineers have constructed and their desired educational paths, “educationalists and practitioners” who determine the structure of the discipline (Grimson & Murphy 2015, p. 177) must ready themselves to catalyze curricular changes. Our assertion is well timed; since, in the last few years, researchers have continually emphasized the benefits of interdisciplinary approaches to engineering (Grimson & Murphy 2015; Mariotti 2021). Scholars like Hayford (1917) and more recently, Mariotti (2021) have acknowledged the valuable nexus between engineering and economic knowledge and have amplified calls for “fruitful knowledge collaborations” within the fields (Mariotti 2021, p. 1).

While there are concerns about the dense nature of engineering course sequences and disciplinary dilution (Benjamin et al. 2022; Saleh 2009), the benefits of endowing future engineers with formal enterprise knowledge are immeasurable. Agreeably, such thinking is far from novel. Researchers of entrepreneurial engineering education and the entrepreneurial mindset in engineering have long acknowledged the sharp increase in university-based entrepreneurship programming for engineering students as well as the associated benefits they offer to various occupational paths (Huang-Saad et al. 2020; Zappe et al. 2013). What might constitute a newer line of thinking is our call for expanding traditional entrepreneurship education by offering more consideration to the concept of enterprise knowledge. We see the broader conceptualization of enterprise knowledge to be a “learning innovation” (Huang-Saad et al. 2020, p. 4), likely to endow students with a more

comprehensive knowledge base that better prepares them to establish entities of their own or for successful enterprising within external organizations.

Finally, in the line of future research, we see ample opportunity to extend and expand the concept of *enterprise knowledge* in engineering. A significant body of research in the field of engineering discusses issues related to entrepreneurship, innovation, management, economics, and business interconnectedly and/or interchangeably. By promoting the use of enterprise as a broader, more encompassing term, we integrate the previously mentioned terms and emphasize their combined roles in the production of commercial activity. This change is timely since entrepreneurship, which has been the focus of most business-oriented engineering education, has recently taken on a broader meaning. Considering the inconsistency and variation associated with these terminologies, we encourage future research which will primarily—and not secondarily as we did—investigate students' enterprise related knowledge. Unlike our current work, a study of this nature would involve the use of data collection tools, whether open or closed ended surveys, interview/focus group protocols, or student artefacts such as essays/reflections which specifically examine participants' enterprise knowledge.

We are adamant about our recommendations for future data collection because we recognize the effects of approaching this current inquiry within the context and confine of a pre-existing study. This study emerged organically from insights participants shared and not necessarily through intentional and tailored data collection. We acknowledge that students were not specifically interviewed on enterprise-related topics. As such, we are inspired to see the breadth of knowledge students may reveal if the data collection process deliberately focused on this construct of interest. Studies may examine the concepts, words, and examples students use to express their enterprise related knowledge and the extent to which this knowledge base develops across the various stages of their undergraduate engineering education. This research is pertinent, given the crucial role that enterprise knowledge plays in the success of commercial engineering activities for larger conglomerates and smaller start-ups alike. Given that current generations of learners, namely Generation Z, appear more philosophically attuned to the impact of contemporary global issues (Manghiuc & Petrescu 2020; Moore et al. 2017), we see these lines of research as fundamental to the development of engineers who are equipped not only with the three C's of the Kern Engineering Entrepreneurial Network (KEEN) framework: *curiosity*, *connections* and *creation of value*, but also a fourth C, which we propose as *contemporary enterprise knowledge*.

LIMITATIONS

Findings from this study produced two constructs of enterprise knowledge: (a) Educational and (b) Economic. Though the constructs provide valuable knowledge, their development highlighted key limitations of the study.

The interview protocol posed questions about participants' engineering experiences before and during college as well as their aspirations for after. The idea of enterprise knowledge was first observed while coding transcripts from the primary study that focused on participants' aspirations (Henderson et al. 2022a). Participants were not directly questioned about enterprise knowledge. Instead, the constructs are interpretative products built on the theoretical foundation previously outlined. Admittedly, the absence of direct data collection on the research topic limited the expanse of knowledge construction that could have occurred.

A similar limitation is associated with participants' reference to race. The interview questions specifically foregrounded participants' experiences as Black men; however, in the subset of data used for this study, only some participants made explicit reference to their race and racial identity (Sellers et al. 1998). The variation in race identity is a compelling observation since there is no definitive reason for its existence. One possibility is that the observed racial erasure or evasion may be the result of implicit bias against Black people and/or Blackness in engineering (Holly & Quigley 2022). Since engineering education privileges whiteness, participants may not have examined the impact of race within the context of the discipline and some perspectives might argue that such considerations may be unnecessary.

CONCLUSION

This study investigated the questions “How do Black male engineering students construct and contextualize enterprise knowledge?” As a result of which, we developed two knowledge constructs from the insights of 20 Black male engineering students. Our analysis of their experiences formed the basis of the educational and economic constructs presented.

The educational construct consisted of participants’ knowledge narratives about time outcomes, timing, and sources of enterprise-related education. From this construct, we came to appreciate how participants identified opportunities for enterprise-related education across various educational routes. The educational construct also showcased the varying professional skills and career advancement pathways that participants associated with enterprise-related learning. In addition to the education construct, we also developed an economic construct. The economic construct presented participants’ collective meaning-making about the economic components of the engineering enterprise. The degree to which participants articulated their economic insights varied. Some participants explicitly referenced economic terminology while others conveyed their knowledge through abstract examples of economic principles and concepts.

These constructs are a valuable contribution to the burgeoning body of research in engineering education and particularly the subset that addresses Black males. It also extends scholarship on entrepreneurial education in engineering and offers a potential opportunity for further research that examines enterprise knowledge in greater detail.

APPENDIX

PROTOCOL EXCERPT

12. What are your career aspirations?
 - a. How do they relate to your major?
 - b. How do or do they relate to your background/biography?
13. What types of support do you believe are needed for Black males to successfully graduate from engineering at your university?
 - a. In your program?
 - b. In your department?
14. Are you interested in pursuing a graduate degree in engineering?
 - a. Prompt- If so, what factors influenced your decision?
 - b. Prompt- If not, what has influenced that decision
15. What types of exposure have you had to information or preparation in regard to pursuing a graduate degree in engineering?
16. If you chose to pursue an advanced degree, what would be the main reason?

DATA ACCESSIBILITY STATEMENT

Access to anonymized transcripts may be granted by Dr Jerrod Henderson (jahende6@central.uh.edu).

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

The second author designed the overarching project from which this study originated. The first author led the design and development of this study. Both authors collaborated on bringing the final product to life.

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REFERENCES

- Adriaens, P., & Faley, T.** (2008, June). *Entrepreneurial business fundamentals for scientists and engineers* [Paper presentation]. 2008 ASEE Annual Conference & Exposition, Pittsburgh, PA. <https://peer.asee.org/3946>
- American Society for Engineering Education.** (2019). *Engineering and engineering technology by the numbers*. Washington, DC. <https://ira.asee.org/wp-content/uploads/2020/09/E-ET-by-the-Numbers-2019.pdf>
- Beal, M., Borg, M. O., & Stranahan, H. A.** (2019). The onus of student debt: Who is most impacted by the rising cost of higher education? *International Research Journal of Applied Finance*, 10(8), 219–231. https://www.researchgate.net/publication/340922748_The_Onus_of_Student_Debt_Who_is_Most_Impacted_by_the_Rising_Cost_of_Higher_Education
- Benjamin, L. S., Henderson, J. A., & Hines, E. M.** (2022). *Is the “E” in engineering for entrepreneurship? An emerging concept of entrepreneurial engineering identity* [Paper presentation]. 2022 ASEE Gulf Southwest Annual Conference, Prairie View, TX. <https://peer.asee.org/39190>
- Benjamin, R.** (2019). *Race after technology: Abolitionist tools for the new Jim code*. Polity Press. <https://www.wiley.com/en-us/Race+After+Technology%3A+Abolitionist+Tools+for+the+New+Jim+Code-p-9781509526437>
- Bhattacharya, K.** (2017). *Fundamentals of qualitative research: A practical guide*. Routledge. <https://doi.org/10.4324/9781315231747>
- Black, K. M.** (1994). An industry view of engineering education. *Journal of Engineering Education*, 83(1), 26–28. <https://doi.org/10.1002/j.2168-9830.1994.tb00112.x>
- Blake Hylton, J., Mikesell, D., Yoder, J.-D., & LeBlanc, H.** (2020). Working to instill the entrepreneurial mindset across the curriculum. *Entrepreneurship Education and Pedagogy*, 3(1), 86–106. <https://doi.org/10.1177/2515127419870266>

- Borchers, A. S., & Park, S. H.** (2010). Understanding entrepreneurial mindset: A study of entrepreneurial self-efficacy, locus of control and intent to start a business. *The Journal of Engineering Entrepreneurship*, 1(1), 51–62. https://www.researchgate.net/publication/256375839_Understanding_Entrepreneurial_Mindset_A_Study_of_Entrepreneurial_Self_Efficacy_Locus_of_Control_and_Intent_to_Start_a_Business
- Bosman, L., Duval-Couetil, N., Mayer, B., & McNamara, P.** (2019). Using online discussions to develop the entrepreneurial mindset in environmental engineering undergraduates: A case study. *International Journal of Engineering Pedagogy*, 9(3), 4–19. <https://doi.org/10.3991/ijep.v9i3.9491>
- Burt, B. A.** (2020). Broadening participation in the engineering professoriate: Influences on Allen's journey in developing professorial intentions. *Journal of Engineering Education*, 109(4), 821–842. <https://doi.org/10.1002/jee.20353>
- Byers, T., Seelig, T., Sheppard, S., & Weilerstein, P.** (2013). Entrepreneurship: Its role in engineering education. *The Bridge*, 43(2), 35–40. <https://www.nae.edu/81235/Entrepreneurship-Its-Role-in-Engineering-Education>
- Caelli, K., Ray, L., & Mill, J.** (2003). “Clear as mud”: Toward greater clarity in generic qualitative research. *International Journal of Qualitative Methods*, 2(2), 1–13. <https://doi.org/10.1177/160940690300200201>
- Chelsom, J. V., Payne, A. C., & Reavill, L. R.** (2005). *Management for engineers, scientists, and technologists*. John Wiley & Sons. <https://www.wiley.com/en-us/Management+for+Engineers%2C+Scientists+and+Technologists%2C+2nd+Edition-p-9780470021262>
- Collins, C. S., & Stockton, C. M.** (2018). The central role of theory in qualitative research. *International Journal of Qualitative Methods*, 17(1), 1–10. <https://doi.org/10.1177/1609406918797475>
- Coşkun, S., Kayıkcı, Y., & Gençay, E.** (2019). Adapting engineering education to industry 4.0 vision. *Technologies*, 7(1), 10. <https://doi.org/10.3390/technologies7010010>
- Duval-Couetil, N., Gotch, C. M., & Yi, S.** (2014). The characteristics and motivations of contemporary entrepreneurship students. *Journal of Education for Business*, 89(8), 441–449. <https://doi.org/10.1080/08832323.2014.933156>
- Duval-Couetil, N., Reed-Rhoads, T., & Haghighi, S.** (2010, October). *Development of an assessment instrument to examine outcomes of entrepreneurship education on engineering students* [Paper presentation]. 2010 IEEE Frontiers in Education Conference, Arlington, VA. <https://doi.org/10.1109/FIE.2010.5673411>
- Duval-Couetil, N., Shartrand, A., & Reed, T.** (2016). The role of entrepreneurship program models and experiential activities on engineering student outcomes. *Advances in Engineering Education*, 5(1). <https://advances.asee.org/wp-content/uploads/vol05/issue01/Papers/AEE-17-E-ship-Couetil.pdf>
- Edwards, T. V., Jr., & Pillapakkam, S.** (2018). Engineering leadership and entrepreneurial personality. In E.-H. Ng, B. Nepal, E. Schott, & H. Keathley (Eds.), *Proceedings of the International Annual Conference of the American Society for Engineering Management* (pp. 1–6). American Society for Engineering Management (ASEM). <https://www.proquest.com/openview/25a581fa8ba9a13c183d1e050480e475/1.pdf?pq-origsite=gscholar&cbl=2037614>
- Galama, T., & Hosek, J. R.** (Eds.) (2007). *Perspectives on U.S. competitiveness in science and technology*. Rand Corporation. https://www.rand.org/pubs/conf_proceedings/CF235.html
- Galende, J.** (2006). Analysis of technological innovation from business economics and management. *Technovation*, 26(3), 300–311. <https://doi.org/10.1016/j.technovation.2005.04.006>
- Galloway, L., Anderson, M., & Brown, W.** (2006). Are engineers becoming more enterprising? A study of the potentials of entrepreneurship education. *International Journal of Continuing Engineering Education and Life Long Learning*, 16(5), 355–365. <https://doi.org/10.1504/IJCEELL.2006.010958>
- Gibson, B., & Hartman, J.** (2013). *Rediscovering grounded theory*. Sage. <https://doi.org/10.4135/9781529799620>
- Gilmartin, S. K., Thompson, M. E., Morton, E., Jin, Q., Chen, H. L., Colby, A., & Sheppard, S. D.** (2019). Entrepreneurial intent of engineering and business undergraduate students. *Journal of Engineering Education*, 108(3), 316–336. <https://doi.org/10.1002/jee.20283>
- Grimson, W., & Murphy, M.** (2015). The epistemological basis of engineering, and its reflection in the modern engineering curriculum. In S. Christensen, C. Didier, A. Jamison, M. Meganck, C. Mitcham, & B. Newberry (Eds.), *Engineering identities, epistemologies and values, Philosophy of engineering and technology* (Vol. 21, pp. 161–178). Springer. https://doi.org/10.1007/978-3-319-16172-3_9
- Hampton, C., Reeping, D., & Ozkan, D. S.** (2021). Positionality statements in engineering education research: A look at the hand that guides the methodological tools. *Studies in Engineering Education*, 1(2), Article 2. <https://doi.org/10.21061/see.13>
- Har-el, Y., & Edwards, T. V., & Ochia, R.** (2021, July). *WIP: Entrepreneurial Identity Formation in First Year Bioengineers* [Paper presentation]. 2021 ASEE Virtual Annual Conference. <https://peer.asee.org/38085>

- Harper, S. R.** (2010). An anti-deficit achievement framework for research on students of color in STEM. *New Directions for Institutional Research*, 2010(148), 63–74. <https://doi.org/10.1002/ir.362>
- Hayford, J. F.** (1917). The relation of engineering to economics. *Journal of Political Economy*, 25(1), 59–63. <https://doi.org/10.1086/252928>
- Henderson, J. A., Hines, E. M., Boyce, A., Golden, M., Singleton, P. II, Davis, J. L., Slack, T., & Junqueira, W.** (2022a). Factors impacting engineering advanced degree pursuit and attainment among Black males. *Journal of Women and Minorities in Science and Engineering*, 28(4), 1–24. <https://doi.org/10.1615/JWomenMinorScienEng.2021036005>
- Henderson, J. A., Hines, E. M., Davis, J. L., Benjamin, L. S. S., Alarcón, J. D., & Slack, T.** (2022b). It's a Vibe: Understanding the graduate school experiences of Black male engineering faculty. *Journal for Multicultural Education*, ahead-of-print(ahead-of-print). <https://doi.org/10.1108/JME-01-2022-0013>
- Holly, J.** (2020). A critical autoethnography of a Black man teaching engineering to Black boys. *Journal of African American Males in Education*, 11(2), 25–42. <https://doi.org/10.7302/21565>
- Holly, J.** (2021a). Criticality is crucial: Fidelity in what we say and what we do. *Studies in Engineering Education*, 2(2), Article 2. <https://doi.org/10.21061/see.78>
- Holly, J.** (2021b). Equitable pre-college engineering education: Teaching with racism in mind. *Journal of Pre-College Engineering Education Research (J-PEER)*, 11(1), 9. <https://doi.org/10.7771/2157-9288.1282>
- Holly J., & Quigley, L. T.** (2022). Reckoning with the harm of anti-Blackness in engineering education: A reparatory justice research approach. *Journal of Women and Minorities in Science and Engineering*, 28(2), 95–110. <https://doi.org/10.1615/JWomenMinorScienEng.2022036667>
- Huang-Saad, A., Bodnar, C., & Carberry, A.** (2020). Examining current practice in engineering entrepreneurship education. *Entrepreneurship Education and Pedagogy*, 3(1), 4–13. <https://doi.org/10.1177/2515127419890828>
- Huffman, T., & Tracy, S. J.** (2018). Making claims that matter: Heuristics for theoretical and social impact in qualitative research. *Qualitative Inquiry*, 24(8), 558–570. <https://doi.org/10.1177/1077800417742411>
- Ignelzi, M.** (2000). Meaning-making in the learning and teaching process. *New Directions for Teaching and Learning*, 2000(82), 5–14. <https://doi.org/10.1002/tl.8201>
- Jennings, L.** (2014). Do men need empowering too? A systematic review of entrepreneurial education and microenterprise development on health disparities among inner-city black male youth. *Journal of Urban Health*, 91, 836–850. <https://doi.org/10.1007/s11524-014-9898-z>
- João, I. M., & Silva, J. M.** (2018, April). Exploring students' entrepreneurial mindset: Insights to foster entrepreneurship in engineering education [Paper presentation]. 2018 IEEE Global Engineering Education Conference, Santa Cruz de Tenerife, Spain. <https://doi.org/10.1109/EDUCON.2018.8363276>
- João, I. M., & Silva, J. M.** (2020). Developing an entrepreneurial mindset among engineering students: Encouraging entrepreneurship into engineering education. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, 15(3), 138–147. <https://doi.org/10.1109/RITA.2020.3008105>
- Katz, A., & Main, J.** (2022). Applying concepts from political science and economics to advance the study of engineering education. *Studies in Engineering Education*, 3(1), Article 1. <https://doi.org/10.21061/see.75>
- Kegan, R.** (1980). Making meaning: The constructive-developmental approach to persons and practice. *The Personnel and Guidance Journal*, 58(5), 373–380. <https://doi.org/10.1002/j.2164-4918.1980.tb00416.x>
- Kolari, S., & Savander-Ranne, C.** (2000). Will the application of constructivism bring a solution to today's problems of engineering education. *Global Journal of Engineering Education*, 4(3), 275–280.
- Kriewall, T. J., & Mekemson, K.** (2010). Instilling the entrepreneurial mindset into engineering undergraduates. *The Journal of Engineering Entrepreneurship*, 1(1), 5–19.
- Latham, S.** (2018). A history of innovation: Pioneering achievements of Black engineers. Link Engineering. https://www.linkengineering.org/Explore/LE_Blog/52515.aspx
- London, J. S., Bekki, J. M., Brunhaver, S. R., Carberry, A. R., & McKenna, A. F.** (2018). A framework for entrepreneurial mindsets and behaviors in undergraduate engineering students: Operationalizing the Kern Family Foundation's "3Cs." *Advances in Engineering Education*, 7(4), 1–12. <http://advances.asee.org/wp-content/uploads/vol07/issue01/Papers/AEE-Mindset-6-London.pdf>
- Manghiuc, I., & Petrescu, C.** (2020). Integration of Generation Z in the professional environment. *LUMEN Proceedings*, 14, 414–425. <https://doi.org/10.18662/lumproc/ibmage2020/30>
- Mariotti, S.** (2021). Forging a new alliance between economics and engineering. *Journal of Industrial and Business Economics*, 48(4), 551–572. <https://doi.org/10.1007/s40812-021-00187-w>
- Mark, S. L.** (2018). A bit of both science and economics: A non-traditional STEM identity narrative. *Cultural Studies of Science Education*, 13(4), 983–1003. <https://doi.org/10.1007/s11422-017-9832-2>
- Martin, L., & Wendell, K. B.** (2021). Reflections on asset-based pre-college engineering education to promote equity: An introduction to the special issue. *Journal of Pre-College Engineering Education Research (J-PEER)*, 11(1). <https://doi.org/10.7771/2157-9288.1325>

- McGee, E. O.** (2016). Devalued Black and Latino racial identities: A by-product of STEM college culture? *American Educational Research Journal*, 53(6), 1626–1662. <https://doi.org/10.3102/0002831216676572>
- McMasters, J. H.** (2004). Influencing engineering education: One (acrospace) industry perspective. *International Journal of Engineering Education*, 20(3), 353–371. <https://www.ijee.ie/articles/Vol20-3/IJEE2501.pdf>
- Mejia, J. A., Revelo, R. A., & Pawley, A. L.** (2020). Thinking about racism in engineering education in new ways [Commentary]. *IEEE Technology and Society Magazine*, 39(4), 18–27. <https://doi.org/10.1109/MTS.2020.3031776>
- Mendelson, M. I.** (1999, June). *Integrated engineering business graduate program* [Paper presentation]. 1999 ASEE Annual Conference, Charlotte, NC. <https://peer.asee.org/7749>
- Moore, J. L., Madison-Colmore, O., & Smith, D. M.** (2003). The prove-them-wrong syndrome: Voices from unheard African-American males in engineering disciplines. *The Journal of Men's Studies*, 12(1), 61–73. <https://doi.org/10.3149/jms.1201.61>
- Moore, K., Jones, C., & Frazier, R. S.** (2017). Engineering education for Generation Z. *American Journal of Engineering Education (AJEE)*, 8(2), 111–126. <https://doi.org/10.19030/ajee.v8i2.10067>
- Morse, J. M.** (1993). Drowning in data. *Qualitative Health Research*, 3(3), 267–269. <https://doi.org/10.1177/104973239300300301>
- National Research Council.** (1991). *Improving engineering design: Designing for competitive advantage*. National Academies Press.
- Nieusma, D.** (2011, June). *Engineering, social justice, and peace: Strategies for pedagogical, curricular, and institutional reform* [Paper presentation]. 2011 ASEE Annual Conference & Exposition, Vancouver, BC. <https://doi.org/10.18260/1-2--17890>
- Nizza, I. E., Farr, J., & Smith, J. A.** (2021). Achieving excellence in interpretative phenomenological analysis (IPA): Four markers of high quality. *Qualitative Research in Psychology*, 18(3), 369–386. <https://doi.org/10.1080/14780887.2020.1854404>
- Ohland, M. W., Frillman, S. A., Zhang, G., & Miller, T. K. III.** (2004). NC State's engineering entrepreneurs program in the context of US entrepreneurship programs. In *VentureWell. Proceedings of OPEN, the annual conference* (p. 155). National Collegiate Inventors & Innovators Alliance. https://www.researchgate.net/publication/255636592_NC_State's_Engineering_Entrepreneurs_Program_in_the_Context_of_US_Entrepreneurship_Programs
- Oprean, C., Kifor, C. V., Negulescu, S. C., & Bărbat, B. E.** (2010). Paradigm shift in engineering education More time is needed. *Procedia-Social and Behavioral Sciences*, 2(2), 3580–3585. <https://doi.org/10.1016/j.sbspro.2010.03.555>
- Reid, K., & Ferguson, D. M.** (2011, June). *Enhancing the entrepreneurial mindset of freshman engineers* [Paper presentation]. 2011 ASEE Annual Conference & Exposition, Rapid City, SD. <https://doi.org/10.1109/FIE.2011.6142734>
- Richardson, P.** (1997). Business success, marketing and the engineer. *Engineering Science & Education Journal*, 6(4), 171–176. <https://doi.org/10.1049/esej:19970405>
- Riggs, J. L., & West, T. M.** (1986). *Essentials of engineering economics*. McGraw-Hill College.
- Sager, B., Fernández, M. G., & Thursby, M.** (2006). Implications of a multi-disciplinary educational and research environment: Perspectives of future business, law, science, and engineering professionals in the technological innovation: Generating economic results (TI: GER®) program. *Technology Analysis & Strategic Management*, 18(1), 57–69. <https://doi.org/10.1080/09537320500520577>
- Saldaña, J., & Omasta, M.** (2018). *Qualitative research: Analyzing life*. Sage Publications. https://books.google.com/books?hl=en&lr=&id=fZi_DQAAQBAJ&oi=fnd&pg=PP1&dq=2018+Qualitative+research:+Analyzing+life&ots=5ehyI2MZHV&sig=5Gf1NfuQ5-QtygSBFTU75Iurw4Y#v=onepage&q=2018%20Qualitative-%20research%3A%20Analyzing%20life&f=false
- Saleh, M.** (2009). *Challenges in engineering education: A view towards the future* [Paper presentation]. 3rd IEEE International Conference on E-Learning in Industrial Electronics (ICELIE), 141–144, Porto, Portugal. <https://doi.org/10.1109/ICELIE.2009.5413196>
- Secules, S., McCall, C., Mejia, J. A., Beebe, C., Masters, A. S., Sánchez-Peña, M. L., & Svyantek, M.** (2021). Positionality practices and dimensions of impact on equity research: A collaborative inquiry and call to the community. *Journal of Engineering Education*, 110(1), 19–43. <https://doi.org/10.1002/jee.20377>
- Sellers, R. M., Smith, M. A., Shelton, J. N., Rowley, S. A., & Chavous, T. M.** (1998). Multidimensional model of racial identity: A reconceptualization of African American racial identity. *Personality and Social Psychology Review*, 2(1), 18–39. https://doi.org/10.1207/s15327957pspr0201_2
- Sellers, V. B., Martin, J. P., & Seraphin, M.** (2022). A narrative inquiry approach to community cultural wealth of Black men in engineering. *Journal of Women and Minorities in Science and Engineering*, 28(4), 69–95. <https://doi.org/10.1615/JWomenMinorScienEng.2021038012>

- Shartrand, A., Moore, L., Costache, E., Fintoc, A. M., Jin, Q., Ling, C., Lintl, F. M., Britos Cavagnaro, L. C., Fasihuddin, H., Breed, A. K., Sheppard, S., Gilmartin, S., Chen, H. L., Duval-Couetil, N., & Besterfield-Sacre, M. E. (2015, June). *Exploring what we don't know about entrepreneurship education for engineers* [Paper presentation]. 2015 ASEE Annual Conference & Exposition, Seattle, WA. https://www.researchgate.net/publication/280840904_Exploring_what_we_don't_know_about_entrepreneurship_education_for_engineers
- Slaughter, J. B., Tao, Y., & Pearson, W., Jr. (2015). *Changing the face of engineering*. Johns Hopkins University Press. <https://muse.jhu.edu/book/42522>
- Smith, J. A. (2011). "We could be diving for pearls": the value of the gem in experiential qualitative psychology. *Qualitative Methods in Psychology Bulletin*, (12), 6–15. <https://doi.org/10.53841/bpsqmip.2011.1.12.6>
- Standish-Kuon, T., & Rice, M. P. (2002). Introducing engineering and science students to entrepreneurship: Models and influential factors at six American universities. *Journal of Engineering Education*, 91(1), 33–39. <https://doi.org/10.1002/j.2168-9830.2002.tb00670.x>
- Sullivan, W. G. (1991). A new paradigm for engineering economy. *The Engineering Economist*, 36(3), 187–200. <https://doi.org/10.1016/B978-0-444-89398-7.50006-9>
- Sullivan, W. G., Wicks, E. M., & Koelling, C. P. (2015). *Engineering economy*. Pearson.
- Timmermans, S., & Tavory, I. (2012). Theory construction in qualitative research: From grounded theory to abductive analysis. *Sociological Theory*, 30(3), 167–186. <http://www.jstor.org/stable/41725511>
- Tolbert Smith, D. (2022). "They are here to support me": Community cultural wealth assets and precollege experiences of undergraduate Black men in engineering. *Journal of Engineering Education*, 1–20. <https://doi.org/10.1002/jee.20480>
- 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. <https://doi.org/10.1002/jee.20029>
- Wharton, D. E. (1992). *A struggle worthy of note: The engineering and technological education of Black Americans*. Greenwood Press.
- Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education*, 8(1), 69–91. <https://doi.org/10.1080/1361332052000341006>
- Zappe, S., Hochstedt, K., Kisenwether, E., & Shartrand, A. (2013). Teaching to innovate: Beliefs and perceptions of instructors who teach entrepreneurship to engineering students. *International Journal of Engineering Education*, 29(1), 45–62. https://www.ijee.ie/articles/Vol29-1/06_ijee2677ns.pdf

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