Foundational Methods for Inclusive Engineering Research: Reflexive Design Choices to Foster Participation and Broaden Impact

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Denise R. Simmons, Ph.D., PE, F.ASEE, PMP, LEED-AP, is a pioneering leader in civil engineering education and workforce development, currently serving as a tenured, full professor in the Department of Civil and Coastal Engineering at the University of Florida. With over three decades of experience in both academia and industry, Dr. Simmons has continually integrated theoretical research and practical application, demonstrating a commitment to evolving engineering competence in its most holistic sense.

Dr. Simmons's recent research efforts have expanded to include a nuanced exploration of communication within engineering education, specifically focusing on developing agentic communicators. Her studies delve into the complex dynamics of communication within research labs, examining how graduate students experience communication mis-cues and identifying strategies to help both students and their advisors navigate and overcome these challenges. She also investigates how faculty approach their communication with graduate students, the concerns they encounter, and the guidance they provide to cultivate stronger, more effective communicators.

Recognizing that effective communication is foundational to leadership and mentorship, Dr. Simmons emphasizes the role of oral communication in building agency. Her work uncovers how mastering oral communication can empower individuals to assert their ideas confidently and navigate professional interactions more effectively. This focus on agency around communication aligns seamlessly with her broader mission to equip engineers not just with technical skills but with the leadership, mentorship, and communication competencies essential for driving innovation and fostering inclusive growth in the field.

Her groundbreaking contributions to engineering education, supported by nearly $8 million in federal funding and over 100 refereed publications, continue to redefine the standards of excellence in the profession. Dr. Simmons's dedication to empowering underrepresented groups and guiding minority-serving institutions earned her the esteemed honor of Fellow Member in the American Society for Engineering Education in 2023, solidifying her legacy as a transformative figure in both the academic and professional engineering communities.

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Abstract

This methods paper examines the development of a longitudinal narrative research design that explores the professional formation and retention of early-career women of color in engineering. While engineering education research has predominantly focused on student experiences prior to graduation, this study addresses a critical limitation by designing a framework to investigate how these women navigate transitions into the engineering workforce. Rooted in asset-based frameworks, this design explores the concept of navigational capital, which encompasses the strategies, resources, and support systems women of color employ to overcome systemic barriers and achieve career persistence.

The purpose of this paper is to outline the methodological choices and conceptual frameworks that guided the research design, including the use of Yosso's Community Cultural Wealth Theory and the Workforce Sustainability Model. We also describe our reflexive approach, examining how our research intentions and practices influenced the design of the interview protocols, data collection methods, and participant engagement strategies. Through an iterative process, the research design emphasizes co-creation of knowledge and participant agency in constructing their career narratives.

The conclusions drawn from this methodological work highlight the importance of centering participant voices, aligning research design with equity-focused aims, and adopting a reflexive stance to uncover nuanced insights into career transitions. This paper offers a foundational resource for researchers aiming to design inclusive studies that address underrepresentation in STEM. By sharing this research design, we contribute to advancing methodological thought and inclusivity in engineering education research and practice. While this paper outlines the methodological framework, future research will empirically explore the most effective ways to prepare and support early-career engineers by leveraging navigational capital.

Introduction

The journey of women of color (i.e., women who do not identify as White) in the US engineering industry is often shaped by systemic barriers that impede both individual and collective progress within the field. These barriers—exclusion, sexism, discrimination, and limited mentorship opportunities—have been well-documented in the literature [1], [2], [3], [4]. Despite various initiatives to promote inclusion, challenges persist, particularly during the critical transition from academia to industry, where the intersecting factors of race and gender often exacerbate these obstacles [5], [6], [7], [8]. This early-career phase, defined as the five years post-graduation, places unique pressures on women of color, demanding greater effort to assert their professional identity and capabilities within predominantly White, male-dominated spaces [4], [9], [10].

This paper presents a reflexive, methods-focused research design that seeks to explore how early-career women of color navigate these challenges through the development and use of

navigational capital, which encompasses the skills, strategies, and resources necessary to overcome structural inequities [11]. Drawing on asset-based theoretical frameworks, including Yosso's Community Cultural Wealth Theory and the Workforce Sustainability Model, the research design is intentionally crafted to illuminate the intersectional experiences of women of color in engineering. By emphasizing the participants' internal assets alongside their external support systems, this research design aims to identify effective strategies for fostering inclusion and career persistence.

Reflexivity—a commitment to critically examining how our beliefs, assumptions, and research practices shape a study—serves as a guiding principle. Reflexivity in this context moves beyond acknowledging positionality to actively interrogating and refining the research process to amplify participant voices, foster mutual respect, and challenge traditional research hierarchies. This paper describes a research design that integrates participant-centered methods such as narrative inquiry, reflective journaling, and member-checking to ensure participants' experiences are authentically captured and interpreted. Additionally, the design includes interviews with participants' self-identified mentors to provide a holistic view of the mentorship dynamics that support early-career success. By situating the research design within NSF's broader mission to diversify STEM fields, this paper serves as a foundational resource for researchers committed to conducting inclusive, asset-based studies that advance equity in engineering education and practice.

Importantly, this paper does not present empirical findings; instead, it is a detailed account of the methodological and conceptual decisions underpinning a research design of a planned and ongoing study. This methods paper underscores the importance of research design as a reflexive and intentional practice, contributing to the growing scholarship on inclusive methodologies and laying the groundwork for future empirical studies on the professional formation and retention of women of color in engineering.

Objectives and Contributions

The primary objective of this paper is to provide a detailed account of a reflexive and intentionally constructed research design, with the aim of:

1. Aligning methodological choices with the study's goal of uncovering the strategies women of color use to navigate engineering cultures;
2. Contributing a replicable framework for researchers seeking to investigate underrepresented populations using participatory and asset-based approaches; and
3. Offering practical guidance for conducting inclusive, ethically grounded research that supports the empowerment of participants.

This paper serves as a foundational resource, documenting the methodological rationale behind the study and its alignment with NSF's mission to broaden participation in STEM. It is intended to guide future researchers in developing rigorous and inclusive methods that account for the complexities of intersectionality in professional spaces.

Theoretical Framing

Theoretical Frameworks: Interweaving Asset-Based and Systemic Approaches. This research design adopts an empowering, asset-based perspective, moving beyond deficit models to emphasize the inherent strengths and competencies women of color bring to their early career transitions in engineering [20]. This dual framework highlights both internal assets and external systemic factors, providing a holistic understanding of career navigation while identifying strategies for support and inclusion. Below, we outline the two core theoretical frameworks that inform our research design: Community Cultural Wealth and the Workforce Sustainability Model.

Community Cultural Wealth and Navigational Capital. The study is grounded in Yosso's (2005) Community Cultural Wealth (CCW) model, which broadens Bourdieu's (1986) concept of capital to recognize the cultural strengths of marginalized groups as valuable resources for navigating institutional barriers [11], [12]. This framework challenges traditional notions of cultural capital by emphasizing the untapped potential of communities of color, thereby reframing these assets as critical tools for persistence and success.

Among the six types of capital defined by Yosso, navigational capital is the focal construct for this research design. Navigational capital refers to the strategic, resilient behaviors, and resourcefulness that women of color employ to navigate exclusionary spaces in engineering education and professional environments [11], [13]. Research has shown that this form of capital plays a pivotal role in overcoming systemic challenges. Samuelson and Litzler (2016) highlighted navigational capital as a key factor in the persistence of African American and Latina/o engineering students [13]. Ong, Jaumot-Pascual, and Ko (2020) further emphasized its importance in addressing racial and gender disparities, illustrating how women of color in engineering leverage navigational capital to mitigate inequities [14].

By centering on navigational capital, our research design seeks to uncover the specific strategies that women of color use to persist through their early careers. This lens provides actionable insights into how institutions can better support these women, fostering smoother transitions from education to the workforce.

Workforce Sustainability Model. Complementing the CCW framework, the Workforce Sustainability Model (Gambatese, Karakhan, & Simmons, 2019) offers a systemic perspective on the external environmental factors that influence career longevity and satisfaction [15]. This model outlines key constructs—such as Equity, Nurturing, and Community—that contribute to inclusive, supportive workplace cultures and promote long-term employee retention.

The model has been validated across multiple industries, including engineering, highlighting its broad applicability and relevance to qualitative research [16]. In our study, this framework provides a structured approach to examining how external factors—such as mentorship quality, workplace culture, and organizational policies—intersect with navigational capital to influence career outcomes.

Synthesis of Frameworks

The integration of Community Cultural Wealth and the Workforce Sustainability Model allows us to explore the interplay between personal agency and systemic support. This dual framework informs both the design and analysis of our study, enabling us to:

1. Capture the lived experiences of women of color in engineering, emphasizing their resilience and strategic navigation of challenges;
2. Identify institutional practices and environmental factors that contribute to career sustainability and inclusion; and
3. Develop actionable recommendations for mentorship and workforce development that align with the NSF's mission to broaden participation in STEM.

Through this combined lens, depicted in Figure 1, we aim to advance understanding of how both internal strengths and external systems shape the professional trajectories of women of color in engineering, offering a robust foundation for transformative change in both research and practice.
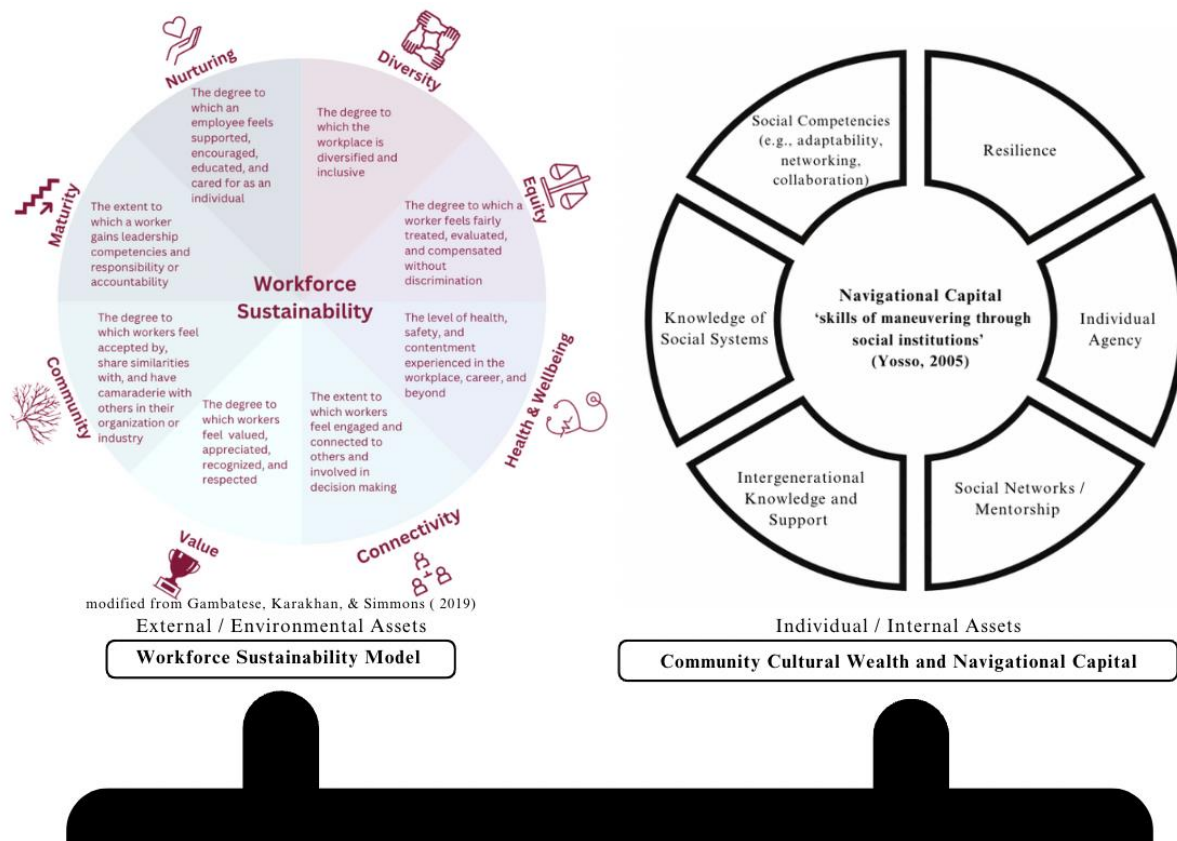

Figure 1: A Strategic Asset-Based Model for Exploring the Nexus of Navigational Capital and Workforce Sustainability

Methodological Foundations: Bridging Theory and Practice

The research design integrates these theoretical underpinnings with qualitative methods, such as narrative inquiry, to explore how women of color engineers leverage their cultural resources to thrive in the profession. By restorying participant data, we aim to reveal how gender, race, and

professional identity intersect within the engineering workforce. The design further incorporates a dual perspective—participant and mentor—to enhance our understanding of professional formation and offer actionable strategies for improving mentorship programs and industry practices. The inclusion of mentor perspectives provides additional insight into how these relationships shape and sustain the development of navigational capital.
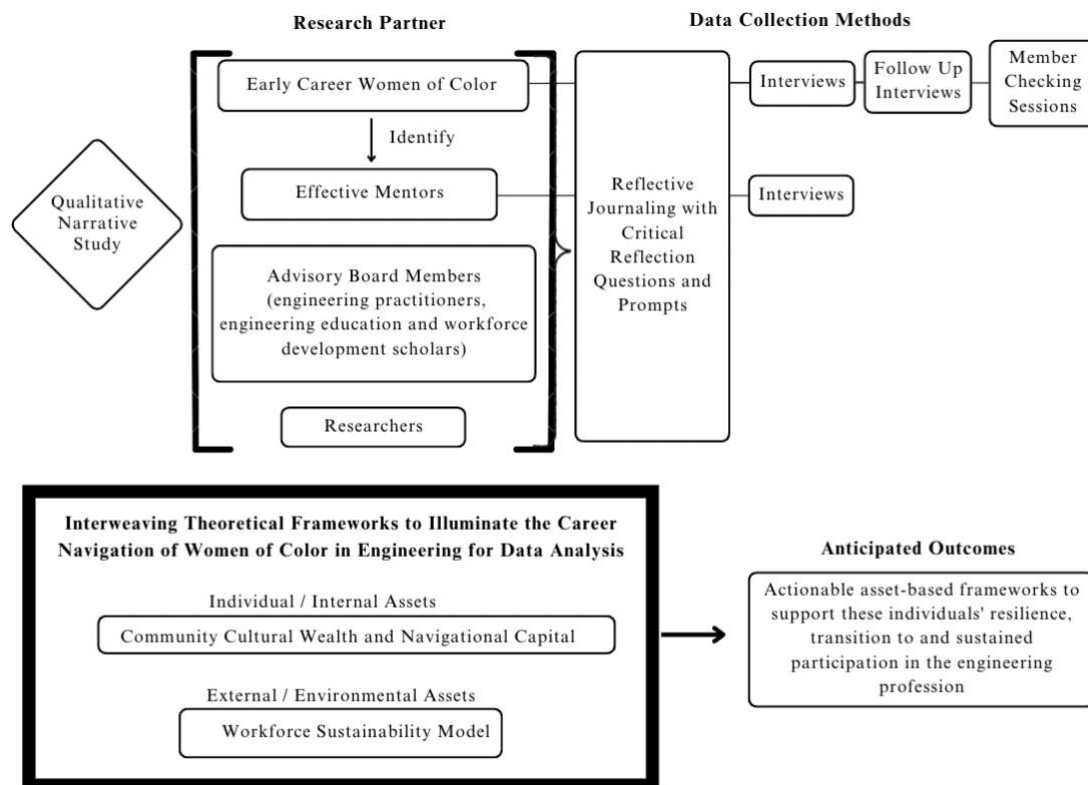
Research Design and Methodology

Figure 2: Research Design

Qualitative Narrative Research. We have developed a qualitative, narrative-driven research design to explore the lived experiences, navigational strategies, and mentorship dynamics of early-career women of color in engineering as shown in Figure 2. Narrative inquiry serves as the methodological backbone, centering participants' stories to uncover deep insights into their professional trajectories within social and cultural contexts [17]. By capturing individual and collective experiences, this design reveals how participants navigate systemic barriers and leverage personal and external assets to persist in their careers [17], [18].

Data collection will span 1-2 years and will include multiple semi-structured interviews [18] informed by the Critical Incident Technique [19], reflective journaling, and voice memos. This longitudinal approach provides a dynamic view of career transitions, tracing the evolution of participants' experiences over time. Participants will engage in member-checking to refine and validate their narratives [20]. Through snowball sampling, participants will identify mentors who will be invited to participate in interviews, offering complementary organizational perspectives.

Reflexivity in Research Design. Reflexivity is a cornerstone of this research design, guiding all methodological choices and fostering transparency and inclusivity. Reflexivity moves beyond positionality to interrogate how researchers' assumptions and experiences shape every phase of the study, from recruitment to data analysis. Pre-planned reflection prompts and journaling by researchers, participants, and advisory board members ensure alignment with participant needs while maintaining trustworthiness. Examples of prompts are shown in the Appendix.

Reflexivity in Action: Designing for Inclusivity and Impact. Reflexivity informs every element of our research design, from participant recruitment to data analysis, ensuring that the study centers the voices and agency of the women involved. Specific reflexive practices include:

- **Recruitment**: We prioritize transparency and inclusivity, leveraging relationships established in a prior longitudinal study while ensuring new participants feel equally valued and represented.
- **Fostering Trust, Rapport, and Safe Spaces:** Building trust with participants is essential and involves offering flexible data collection methods that suit their preferences. In our research, participants found voice memos and text messages to be the most convenient, allowing them to share real-time reflections comfortably. Allowing participants to choose where interviews and reflections take place further promotes safety and respect, ensuring they feel free from harm or power imbalances [21]. Drawing from Third Space Theory, providing neutral or alternative locations (i.e., outside of a research lab or their work environment) fosters inclusivity and empowers underrepresented voices [22]. For example, one participant chose to complete her reflection journal when she felt relaxed by a peaceful pond, sharing: "Hey Bestie, I'm taking time because I'm sitting by the pond watching the ducks…" This illustrates the importance of creating self-chosen, safe spaces and building genuine relationships and facilitate honest, meaningful conversations and gather rich data and evidence on a topic.
- **Interview Protocols**: Culturally sensitive and participant-centered interview protocols are designed to create a supportive environment, allowing participants to reflect openly on their career journeys.
- **Mentorship Component**: Recognizing the influence of mentors on participants' professional development, we include interviews with mentors identified by the participants, ensuring a holistic view of the support systems that facilitate career persistence and growth.
- **Restorying as Method**: Narrative inquiry methods are used to honor the participants' lived experiences, allowing us to trace their professional journeys and highlight the strategies they employ to overcome systemic barriers.

These decisions demonstrate our commitment to conducting research that not only generates new knowledge but also challenges traditional research paradigms by actively engaging participants in the research process.

Data Analysis

The data will be analyzed using a hybrid thematic analysis approach, applying constructs from the theoretical frameworks of Community Cultural Wealth and the Workforce Sustainability Model. Codes and themes will be developed iteratively [23], triangulated across data sources to provide a holistic understanding of how navigational capital and workplace environments influence participants' career pathways.

Ethical and Participatory Considerations

Participant-Centered Approach. This study prioritizes ethical engagement through a participant-centered design. Culturally sensitive interview protocols and reflective journaling empower participants to share their narratives authentically. By maintaining open channels for feedback, the study fosters trust and ensures that participant voices remain central throughout the research process.

Informed Consent and Confidentiality. Participants will be fully informed about the study's purpose, methods, and intended outcomes, with consent obtained prior to participation. Confidentiality measures, such as pseudonyms and secure data storage, will protect participant identities and ensure ethical data handling.

Collaborative Reflexivity. Advisory board members and participants will engage in ongoing discussions to refine research questions, interview prompts, and reflection exercises. This collaborative reflexivity ensures that the study remains responsive to participant needs and contextual nuances.

Contributions, Impacts, and Implications

This reflexive, methods-focused research design paper offers a foundational contribution to the field of engineering education research by documenting the intentional design of a longitudinal narrative study centered on early-career women of color in engineering. The methodological approach serves as a replicable framework for conducting asset-based, participant-centered research that emphasizes reflexivity, inclusivity, and empowerment. By explicitly detailing the research design choices—such as the integration of narrative inquiry, participant-driven mentorship insights, and ongoing reflective journaling—this paper provides a model for researchers seeking to investigate underrepresented populations with both methodological rigor and ethical sensitivity.

One significant contribution lies in the research design's deliberate focus on reflexivity as a guiding principle for the research process. Reflexivity ensures that methodological choices are critically examined and continually aligned with the study's overarching goals: to amplify participants' voices, explore their experiences, and promote equity in engineering environments. By incorporating reflective practices throughout the research process, this study highlights the importance of adapting research designs to the unique needs and insights of participants, offering a methodological template that fosters deeper engagement and trustworthiness.

Additionally, this paper advances theoretical application by demonstrating how asset-based frameworks such as Community Cultural Wealth and the Workforce Sustainability Model can be operationalized to guide research design, data collection, and analysis. The synthesis of these

frameworks provides a robust lens for examining how systemic factors intersect with personal agency to shape career experiences. This methodological contribution underscores the importance of leveraging theoretical insights to inform practical research decisions, bridging the gap between theory and empirical investigation.

The implications of this methods paper extend beyond its immediate research context, providing guidance for scholars designing studies that aim to capture the nuanced experiences of underrepresented groups in STEM. By emphasizing participant-centered methodologies and reflexive practices, the paper offers a pathway for advancing equity-oriented research that not only generates knowledge but also challenges traditional research paradigms. This contribution is particularly timely as the engineering education community seeks to expand its methodological repertoire to address pressing issues of diversity, inclusion, and workforce sustainability.

The implication of this paper extends beyond academia. By uncovering the strategies and support systems that enable women of color to persist and succeed in engineering, this work informs evidence-based practices for mentorship, policy, and organizational change. In sharing this methodological foundation, we contribute to a more inclusive and dynamic engineering workforce capable of addressing the complex global challenges of the future.

Finally, this work encourages broader discussions about research ethics, positionality, and the role of researchers in fostering inclusive scholarship. It invites future researchers to critically evaluate their own research practices, promoting a culture of transparency and accountability in the pursuit of equity and inclusion in engineering and beyond. The insights and frameworks presented here are intended to inspire methodological innovation and serve as a resource for scholars committed to advancing socially impactful research.

Discussion and Conclusions

Aligned with calls in engineering education literature to move "beyond the monolith," this work advocates for critical theoretical frameworks that account for the nuanced experiences of underrepresented populations, such as Latiné/x/a/o students in engineering [24]. Rather than treating these populations as homogeneous groups, this research design employs methods like narrative inquiry to illuminate the richness and complexity of individual stories. This approach provides a more contextualized understanding of their unique challenges and opportunities.

The methodological approach also highlights the value of reflective journaling as a tool for amplifying the voices of nontraditional students in engineering. Reflective journaling creates space for participants to articulate the complexities of their lives, including their support systems, barriers, and interactions, offering researchers deeper insights into their experiences [25]. Additionally, the study underscores the importance of research reflexivity in qualitative designs, sharing reflection questions that foster transparency and enrich discussions around the researcher-participant dynamic [26]

This work contributes to broader conversations in the literature that address the racialized and gendered experiences of underrepresented students, particularly Black students, and the role of internal assets and external environments in shaping outcomes like persistence and thriving in engineering [27]. By centering participants' voices and applying asset-based, reflexive methods,

this work advances our understanding of how to research and support diverse populations in STEM education and career transitions. This methodological approach aims to uncover data that is currently missing from the literature. While the immediate implications focus on women with similar identities, we believe these practices may be transferable to studying individuals at the early stages of their careers more broadly. Future empirical work seeks to impact practice by supporting the development of navigational capital for women and others in similar positions.

Ultimately, this study positions itself as both methodologically robust and innovative, offering a blueprint for designing inclusive, equity-driven research. By combining critical theoretical frameworks, participatory methods, and reflexive practices, this work challenges existing biases in educational research and contributes to the development of more inclusive engineering education. It provides a touchstone for future scholars seeking to engage underrepresented populations with ethical, participatory designs while addressing practical challenges in engineering education research and practice. We hope that sharing our research design will spark further discussions within the ERM and engineering education communities; we warmly welcome feedback, insights, and collaborations to refine and expand these approaches, amplifying their impact.

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Appendix: Reflection Questions and Prompts for Various Research Groups

Research Partner	Questions / Prompts
Advisory Board – **Scholars in Engineering Education, Mentors, and Engineering Workforce Development Industry Leaders**	• Given the complexities of engineering cultures, how can each research partner (OR you/your org) collaboratively develop a discourse on navigational capital that resonates with the experiences of women of color in engineering, and which specific strategies or interventions have been effective in your respective domains? • What innovative approaches or models in workforce sustainability have shown promise in your fields/organization, and how can they be adapted to support the professional development of women of color in engineering sectors? • From a policy and ethical standpoint, what are the imperative considerations that each research partner (OR you/your org) must prioritize to ensure the societal impact of this research honors the lived experiences and promotes the well-being of women of color in engineering?
Investigators	*Ongoing Reflection Prompts:* • What specific methods and strategies can we employ to engage women of color in conversations about their navigational capital, ensuring their voices and experiences are central to our understanding of workforce sustainability in engineering? • As we conduct this research, what policies should we advocate for or help develop to support the advancement of women of color in engineering, and what ethical considerations are paramount when documenting and sharing their stories? • How can we measure the societal impact of our research, and what indicators should we prioritize to assess the effectiveness of interventions aimed at improving professional development for women of color in engineering?
Participants – **Early Career Women of Color in Engineering**	These questions are aimed at uncovering personal narratives and actionable insights that can inform interventions and policy recommendations to support women of color in engineering fields. • How can the research partners discover the skills and strategies that are essential to early career women of color successful navigation of engineering careers? • Can you identify a mentor (i.e., a person from anywhere in your life) that has been critical in supporting you as you navigate an early career in engineering? Would you be willing to connect them with us? • What outcomes do you hope to see as a result of this research? **Navigational Capital Experiences:** Can you share an instance when you successfully navigated a professional challenge in engin2eering? What resources or support systems were instrumental in this process? **Mentorship and Professional Growth:** How has mentorship (formal or informal) influenced your career trajectory, and what qualities in a mentor have been most beneficial for your professional development? **Workforce Sustainability:**

	What aspects of your work environment make you feel valued and supported, and what changes would you like to see to enhance the sustainability of careers for women of color in engineering?
Participants – **Mentors of Early Career Women in Engineering**	These questions are intended to garner insights from the mentors about their mentorship styles, perceptions of the barriers faced by women of color in engineering, and their role in fostering a diverse and supportive engineering environment. **Mentoring Approach:** In your experience as a mentor, what approaches have you found most effective in supporting the professional development of women of color in engineering? **Challenges and Strategies:** Can you describe some of the unique challenges you believe your mentees face in the engineering field, and how do you guide them in navigating these challenges? **Perceptions of Workforce Sustainability:** From your vantage point, what key factors contribute to a sustainable and inclusive engineering workforce, particularly for women of color, and how do you incorporate these into your mentorship? **Decision-Making Support:** How do you assist your mentees in evaluating their career options and making critical professional decisions? Could you provide an example where your guidance was pivotal? **Navigational Capital Building:** What skills or resources do you emphasize for maneuvering through industry challenges? **Reflecting on Mentorship Outcomes:** Looking back on the progression of your mentees, how do you assess the impact of your mentorship in their career navigation and decision-making processes? These questions aim to understand the role mentors play in developing the decision-making acumen of their mentees and the effectiveness of the mentorship provided. **Evaluating Mentorship Effectiveness:** When you think about the advice and support you've given, can you tell us about a time you saw it make a real difference in your mentee's career path?