

“This Is Bigger Than Me:”

A Multiple Case Narrative Analysis of Sociopolitical
Development within Black Engineers' Career Journeys

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Abstract

Exploring the stories of Black engineers provide an opportunity to challenge dominant narratives about the apolitical nature of engineering work and realize the potential of bridging the socio-technical divide. Sociopolitical development (SPD) is an inclination towards social justice, the motivation to address social inequality in surrounding environments, and the formation of social agency to address contextual oppression. The purpose of this multiple case narrative study is to explore the process of SPD within five Black engineers’ narratives who are inspired to address social inequities through their engineering work. The overarching research question is: How does the SPD process unfold through the career narratives of Black engineers? Through the multiple settings surrounding Black engineers’ career development, this research provides insight into how engineering stakeholders influence the cultural values underlying the nature of engineering work. Throughout their career narratives, Black engineers’ awareness, behavior, and evaluations of critical consciousness evolve. Events shaping their SPD are also mapped to the socio-ecosystems. The movement through SPD elements depict the holistic nature of the SPD process for Black engineers experiences in childhood, formal education, and the workforce. These results contribute to engineering education literature by: (1) presenting a counter-narrative of engineering work that accounts for the perspectives of Black engineers; (2) highlighting the sense of agency that is necessary to integrate social justice elements in engineering practice; (3) emphasizing the utility of critical consciousness development in establishing a sense of fulfillment in engineering identity; and (4) discussing the influence of critical reflection and social identities on political efficacy and action. Insights from this study should compel engineering stakeholders to reflect on how engineering values perpetuate inequities in engineering pathways and engagement.

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General Audience Abstract

Exploring the stories of Black engineers provide an opportunity to challenge dominant narratives about the neutral nature of engineering work and realize the potential of bridging the separation between social and technical spaces. Sociopolitical development (SPD) is an inclination towards social justice, the motivation to address social inequality in surrounding environments, and the formation of social agency to address contextual oppression. The purpose of this multiple case narrative study is to explore the process of SPD within five Black engineers' narratives who are inspired to address social inequities through their engineering work. The overarching research question is: How does the SPD process unfold through the career narratives of Black engineers? Through the multiple settings surrounding Black engineers' career development, this research provides insight into how engineering stakeholders influence the cultural values underlying the nature of engineering work. Throughout their career narratives, Black engineers' awareness, behavior, and evaluations of critical consciousness evolve. Events shaping their SPD are also mapped to the socio-ecosystems. The movement through SPD elements depict the holistic nature of the SPD process for Black engineers experiences in childhood, formal education, and the workforce. These results contribute to engineering education literature by: (1) presenting a counter-narrative of engineering work that accounts for the perspectives of Black engineers; (2) highlighting the sense of agency that is necessary to integrate social justice elements in engineering practice; (3) emphasizing the utility of critical consciousness development in establishing a sense of fulfillment in engineering identity; and (4) discussing the influence of critical reflection and social identities on political efficacy and action. Insights from this study should compel engineering stakeholders to reflect on how engineering values perpetuate inequities in engineering pathways and engagement.

Dedication

To past, present, and future marginalized individuals that endure to take on the mantle for change: We gonna be alright! This is bigger than me, you and us. We must do what needs to be done. We have systems to change, and we cannot do that unless we take care of ourselves. We cannot wait for other people to understand or believe us. The work starts within and it is for us, by us. Our souls are for us to keep, us to restore and us to use them exactly how we decide we want to.

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1. Chapter 1: Overview of Motivation and Research Design

1.1 Introduction

This qualitative study explores the lived experiences and worldviews of Black engineers who address social inequities through their careers in disaster management. A multiple-case narrative research design was utilized to collect data and analyze how Black engineers narrate their shifts in worldviews as they address social inequities through their engineering careers.

The chapter begins with a description of the dissertation study's motivation and significant insights from a literature review surrounding sociopolitical development. Following the motivation section, there is an explanation of the decision to focus on Black engineers as the sample population to investigate how sociopolitical development emerges in practice. Lastly, the chapter will also provide an overview of my research design, and the significance of this study.

1.2 Motivation

This study is motivated by (1) the cultural context surrounding engineering, (2) the placement of social justice on the boundaries of engineering work and tensions between the two, and (3) the development of racially minoritized engineers as they persist in engineering environments. This section will discuss how the development of critical consciousness and inclinations toward social justice in engineering practice are addressed in engineering education literature. Though the terms used in the literature vary (e.g., social responsibility, civic engagement, or equity ethic), in the context of this dissertation, the phenomenon of critical reflection/motivation/action will be referred to as 'sociopolitical development' (SPD).

1.2.1 Cultural Context Surrounding Engineering

Underlying discussions about the engineering field's role in and impact on society, the purpose of engineering education, and definitions of its success (e.g., engineering proficiencies and degree attainment) have been topics of debate for over a century and are constantly debated (National Academy of Sciences, 2007; National Science Board, 2004; President's Council of Advisors on Science and Technology, 2012; Mann, 1918; Wickenden, 1945). Engineering stakeholders—explicitly or implicitly—communicate and often emphasize qualities and competencies that they believe are needed by engineering (and/or STEM) graduates if we are to address the significant challenges of the present and future effectively.

One shared purpose of engineering is that engineers should engage in efforts to improve society by solving social and technological problems in equitable ways that advance humanity. Curricular reform strategies (e.g., accreditation criteria, culturally relevant teaching, and new engineering education models) tend to depict the engineering field as a heterogeneous, socio-technical field that seeks to improve society (Leydens and Lucena, 2018; Cech, 2014; Riley, 2008). The National Academy of Engineering's (2008) *Grand Challenges for Engineering* include a unifying set of priorities for engineers in the 21st century that has received significant support from engineering stakeholders (e.g., researchers, educators, practicing engineers, and policymakers). These challenges include priorities such as advancing personalized learning, providing better healthcare, improving urban infrastructure, making clean water more accessible, and increasing standards of living (NAE, 2008). Together, the curricular reforms and global challenges communicate the role in society that engineering stakeholders imagine for the field of engineering.

Beyond grand challenges and reform strategies, there have also been national calls for STEM graduates to play an integral role in eliminating severe inequities and injustice globally (Holdren, 2008; Vaz, 2005). A fundamental cause of challenges in healthcare, urban infrastructure, and standards of living is the severe poverty and other structural inequalities that remain throughout the world, despite tremendous growth in new technologies and advances in science over the last several decades (United Nations, 2011). These disparities disproportionately impact minoritized groups worldwide, including people of color in the U.S. (Ali Khan, 2010; Baker et al., 2006; DeNavas-Walt et al., 2012). Moreover, the severity of these inequities are intensified when disasters strike communities (Tierney, 2007); research on disaster management helps expose the understanding of the social structure and social inequalities. However, within the engineering field, research on addressing social justice issues remains within the margins of engineering work.

1.2.2 Social Justice on the Boundaries of Engineering Work

While advancements in science and technology have significantly impacted human endeavors, engineering in the context of social justice discussions has remained elusive. One explanation for the limited conversations around social justice and engineering is that stakeholders often exclude the perspectives and ideologies of marginalized groups (e.g., people of color) when defining the role of engineering in society. As a result, engineering paradigms often ignore the social and environmental oppression of people of color within and outside of engineering practice and education (Hammonds & Herzig, 2008; Harding, 2006).

As we imagine a future of engineering practice and education inclusive of marginalized ideologies, we must discuss the role of engineering as it relates to social justice. STEM scholars

have advocated for a more comprehensive definition of success, including social justice outcomes, by connecting STEM to sociopolitical developments (Baillie et al., 2011). Centering social justice and equity in STEM education would push the boundaries of traditional academic success measures (e.g., acquiring STEM knowledge, competencies, and degrees). Moving beyond these measures will guide the engineering field toward the goal of developing future leaders in STEM fields who are committed to creating a more equitable society.

The tension between engineering and social justice reveals competing demands on the curricular priorities of engineering education within the United States. On one end, the seemingly dominant perspective of engineering's societal role focuses on maintaining U.S. global economic competitiveness (e.g., Camuti, 2006; West, 1992) and technical prowess (Newberry, 2007). According to this perspective, engineering student success is narrowly defined using educational outcomes and measures, such as engineering knowledge, competencies, and degrees awarded. As a result, we have an engineering education system that prioritizes technical aspects of the profession to advance global economic competition over social aspects (Labov, 2006; Harding et al., 2009; Polmear et al., 2018). On the other hand, critical and social justice scholars advocate for engineers to consider their professional social responsibility and intentionally address contemporary issues (Zandvoort, 2008; Nieuwma, 2013; Niles et al., 2020). These scholars advocate for incorporating topics such as social responsibility, civic engagements, and equity orientations to broaden and improve the impact of engineering on equity and the human good (Baillie et al., 2011). Along with these aims is a consideration of how engineering education can develop students' understanding of social issues and students' potential to rectify structural inequities.

Discussions about engineers' roles in addressing contemporary issues include the importance of developing future engineering leaders committed to creating a more equitable society. However, engineering education literature has highlighted the under-emphasis of the sociopolitical outcomes in education necessary to address social inequities (Riley, 2008; Lucena, 2013; Leydens & Lucena, 2017). For example, Gustein's (2006) work emphasizes that without concern for social good or injustice, exclusively prioritizing the needs of capitalism in engineering education can efficiently serve to reproduce the dominant social order. Furthermore, this priority in engineering education ignores the importance of developing marginalized students' potential to critique and improve the conditions of their own lives through engineering (Calabrese Barton, 2001; Gutstein, 2006).

Recent studies on how engineers address social and ethical implications have identified a tension between engineering and social justice topics. The work of Morgan et al. (2019) reveals barriers to engineers' political involvement, such as limited exposure to motivating political events, the privilege of private gain, and the situated position of politics on the outside borders of engineering. Similarly, work by Niles et al. (2020) reveals that engineering students struggle to engage with considerations of public welfare due to their rigid engineering identity, the higher value of technical aspects surrounding engineering work, and the ambiguity of ethics. Kabo and Ballie (2009) found it beneficial to relate social justice concepts to threshold concepts (troublesome knowledge) because it captures the struggling nature and journey of incorporating social justice concepts into existing engineering knowledge. The findings of these studies indicate barriers in the engineering education process of developing engineers committed to social justice.

These dominant discussions within the sub-field of social justice and engineering are missing an understanding of the developmental process through which engineers do come to address social inequities within their work. For instance, studies by Morgan et al. (2019), Niles et al. (2020), and Kabo and Ballie (2009) fail to acknowledge that the process of developing identities related to social justice may potentially be taking place on various levels for engineers. In addition, they look at student development in a vacuum at one point in time through cross-sectional focus groups, program participation, and classrooms, without acknowledging that this development may take place over time and outside of the engineering curricula. The interventions designed to incorporate social justice into engineering paradigms do not account for stages in understanding the social justice implications of engineering work.

Lastly and most importantly, the authors do not account for the participants' identities in their studies. Participants' identities provide the cultural context surrounding a phenomenon so that the researcher can better understand how and where the desire to address injustices emerges in the narrator's experiences. This literature motivates the need to design a study that accounts for the context of SPD within and beyond academia while identifying the process through SPD by analyzing Black engineers' professional narratives.

1.2.3 The Development of Racially Minoritized Engineers

Racially minoritized engineers are more likely to address systems of oppression in their work (Cantù, 2012; Naphan-Kingery et al., 2019); however, to persist in engineering, they are unfortunately forced to operate within systems of oppression. For example, their “success” within engineering structures depends on their ability to navigate organizational structures and policies not designed with marginalized identities in mind (Samuelson & Litzler, 2016).

Therefore, racially minoritized engineers are more inclined to critique social oppression due to their unique experiences with social suffering and their desire to eliminate injustices caused by systems of oppression within STEM (Naphan-Kingery et al., 2019). Identifying injustice and being willing to remedy it is related to developing critical reflection/motivation/action. This dissertation will refer to this phenomenon as ‘sociopolitical development’ (SPD).

More broadly, SPD can be defined as “an orientation toward social justice, a motivation to transform sociopolitical inequity in one’s environment, and the development of a healthy sense of self and feeling empowered to exercise one’s agency in the context of structural oppression” (Diemer et al., 2009, p. 318). In the context of this study, SPD is inclusive of promoting equity through the understanding of social issues, as well as related to civic and social responsibility, social agency, civic awareness, critical consciousness, civic/public engagement, and equity ethic (Garibay, 2018; McGee & Bentley, 2017; Baillie et al., 2011; Jordan, 2006; Vaz, 2005; Diemer et al., 2017; Niles et al., 2020). In practice, this can mean an engineer identifying social forces at play as they engage in their engineering work. As a theoretical foundation, SPD enables a greater understanding of engineers’ development and motivation to address oppression in their practice.

In developing future engineers, critical STEM scholars argue for social justice outcomes that discuss power relations and structural barriers in engineering practice (Calabrese Barto & Tan, 2011; Gutstein, 2006). Future engineering professionals' knowledge, skills, and attributes will need to include a greater emphasis on resolving inequities if the engineering field addresses contemporary challenges effectively. Social justice relates to the role of engineers in society and investigates ways that professionals can utilize their training and skills to resolve inequities. However, one topic that is understudied at the intersection of engineering and social justice

literature is the phenomenon of SPD development in engineers. This study focuses on marginalized engineers' journey through SPD to better understand how marginalized engineers develop an interest in promoting social justice through their engineering practice and redefine the role of engineers in society. The following section will expand on how sociopolitical development is situated in engineering and social justice literature.

1.3 Engineers from Marginalized Communities as Potential Leaders

This dissertation focuses on Black engineers who have incorporated social justice values in their engineering practice. These engineers are potential leaders in developing equitable societal outcomes alongside engineering practice. Students from communities of color within engineering tend to desire to broaden and improve the impact of engineering on equity and the human good. In particular, McGee and Bentley's (2017) work highlights how Black engineering students are highly likely to develop an "equity ethic." Equity ethic is "a principled concern for social justice and for the well-being of people who are suffering from various inequities" (McGee & Bentley, 2017, p. 4). Scholars provide evidence of engineers' motivation toward social justice by exploring underlying reasons for the inspiration and perseverance of racially minoritized STEM students (McGee et al., 2016; Naphan-Kingery et al., 2019). However, there is a gap in understanding the pathways engineers navigate to address social inequities and how they act on this motivation.

Additionally, careers are often utilized as a mechanism of identity expression and desired impact (Holland et al., 1980). Black engineers are highly likely to adopt social justice perspectives to address societal challenges due to their experiences with social suffering (Naphan-Kingery et al., 2019). There is ample research on the association of contextual factors

(e.g., students' race, ethnicity, socio-economic status, gender) with students' career beliefs and interests (O'brien et al., 1999; Beasley, (2011); Gibbs et al., 2014; Ali et al., 2021). In particular, a study by Beasley (2011) focused on why college students opt out of high-paying jobs and found that Black college students viewed work as a means of expressing a sense of connectedness with the responsibility to, and care for, the Black community. This evidence further motivates the need to explore the narratives of Black engineers who desire to address social inequities throughout their careers.

1.4 Research Overview

The purpose of this multiple case narrative study is to explore the process of sociopolitical development within five Black engineers' narratives who are inspired to address social inequities through their engineering work. Research on SPD in engineers will provide insight into how engineering stakeholders influence the cultural values underlying the nature of engineering work throughout the multiple settings of Black engineers' career development. The overarching research question guiding this study is: *How do pathways through sociopolitical development manifest within the career journeys of five Black engineers who aspire to address social inequities through their engineering work?* Sociopolitical development (SPD) can be defined as “an orientation toward social justice, a motivation to transform sociopolitical inequity in one's environment, and the development of a healthy sense of self and feeling empowered to exercise one's agency in the context of structural oppression” (Diemer et al., 2009, p. 318). In answering this research question, this study explores how Black engineers narrate their awareness and experiences through engaging in disaster management to further understand sociopolitical development in engineers.

1.5 Significance

Through storytelling, the outcomes of this study capture the lived experiences and the surrounding context of Black engineers developing SPD. The results highlight the need for a greater emphasis on sociopolitical development within engineering education as we theorize the future of the engineering field. I demonstrate that this greater emphasis can be accomplished by exploring the existence and manifestations of sociopolitical development through the lived experiences of Black engineers who work to address contemporary issues in their engineering work.

These stories will challenge dominant narratives about engineers' holistic disengagement with social justice (Leydens & Deters, 2017) and offer counter-narratives of Black engineers who desire to address social inequities through social agency and work for social change. An anti-deficit approach (Mejia et al., 2018; Harper, 2010) to this study allowed me to explore how Black engineers maintain their sense of self and express their identity throughout their careers and interface with social inequities.

1.6 Looking Ahead

This chapter provided the background knowledge of engineering stakeholders' views of the heterogeneous, socio-technical engineering field to situate the context in which we prepare engineers for work. The background briefly outlined the motivation, literature, and critical decisions for a research design addressing the literature gaps in understanding SPD. It highlights details of a plan to gather data that addresses the overarching question and the significance of this work. Chapter 2 will expound upon literature surrounding engineering and social justice,

Black engineers, and SPD to clarify the literature gaps this dissertation study is designed to address.

2. Chapter 2: Literature Review

2.1 Introduction

To explore how Black engineers have incorporated social justice in their engineering praxis in contrast to the normative engineer narrative, I will provide an overview of literature related to the field of engineering and socio-political development (SPD). The purpose of chapter 2 is to situate the reader in the most recent studies related to SPD and explain why a study focused on SPD will broaden the narrative surrounding engineering.

The first section will briefly introduce how SPD has been conceptualized across engineering education and community psychology literature. Then, section 2.3 will provide a high-level overview of the typical narrative surrounding engineering work and point to the need for a counternarrative. Next, section 2.4 will zoom into the preparation of engineers and present the known barriers to incorporating social elements in the nature of engineering work. Section 2.4.1 will center on strategies used to reform education and present critiques of these methods. Section 2.4.2 will position Black engineers as exemplary engineers who have successfully incorporated social elements into engineering paradigms due to their lived experiences. After providing insights from the literature, the following sections will summarize knowledge gaps and remind the reader that the dissertation study is designed to address gaps in the literature review. Finally, section 2.7 will center on the theoretical foundation of SPD and explain how it informs this dissertation research. Holistically, this chapter aims to map significant insights from the literature to the problem addressed by the dissertation study. However, I will first define the terms throughout engineering education literature related to SPD.

2.2 Understanding Engineers' Sociopolitical Development (SPD) Terms

In chapter 1, I described how the cultural context surrounding engineering and the placement of social justice on the boundaries of engineering limits the development of engineers' political, social, and civic responsibility. Insight into the development of political, social, and civic responsibility will contribute to engineering education's methods of professional training to eliminate inequities. Most of the research on the development of political, social, and civic responsibility is situated in the university context. The university context presents a limitation in understanding the outcomes of SPD because we do not understand the level of understanding of social forces at play in social prior to the university and how that impacts the individual in the workplace. However, literature in engineering education has provided insights into strategies that attempt to develop political, social, and civic responsibility. This section will give an overview of how research related to engineering education explores concepts associated with SPD.

Within engineering practice and education, there are numerous ways that social justice is conceptualized, along with terms that refer to developmental competencies related to social justice. For example, "engineering to help" programs such as Engineers Without Borders and Engineers for a Sustainable World use concepts like civic/social responsibility and social sustainability in describing their values in addressing social inequities instead of calling it social justice (Schneider, Lucena, Leydens, 2009). Therefore, within this literature review, civic/public engagement, social responsibility, critical consciousness, political engagement, equity ethic, and SPD are considered terms related to the development of political, social, and civic responsibility as defined in Table 1. In the context of this dissertation I am equating the development of social justice inclinations to SPD.

Chapter one introduces how SPD is a developmental process that describes how individuals engage with critical reflections and actions. SPD will be an umbrella term for developing political, social, and civic responsibility as individuals incorporate awareness and analysis of social inequities in their engineering practice. According to Reddick et al. (2018), civic/public engagement typically involves neutral responses to social inequality that ignores the ways social systems impacts groups of individuals; for this reason, it will relate to a lower stage of SPD. A higher stage of SPD will relate to equity ethic, which McGee & Bentley (2017) describe as a moral concern for social justice and the well-being of people suffering from various inequities.

Black engineers with a high level of SPD were the target population for this dissertation study; however, it is helpful to incorporate terms such as social responsibility, critical consciousness, and political engagement to describe the components of SPD in its higher-level stages. For instance, critical consciousness typically refers to the presence of awareness, reflection, and a sense of obligation to address social inequities (Heberle and Rapa, 2020). According to research on SPD, critical consciousness is needed to be socially responsible. Social responsibility is the commonly used term for how engineers are committed to addressing equity throughout society through humanitarian and sustainability avenues in engineering education literature (Pritchard & Baillie, 2006; Amadei, 2004). Political engagement is not as commonly used in engineering education literature; however, it is helpful to describe the political nature of SPD as an individual considers how power shapes social systems (Niles, Roundbari, and Contreras, 2020).

Though the terms used in the literature vary across bodies of literature to describe SPD, I have included definitions of civic/public engagement, social responsibility, critical

consciousness, political engagement, and equity ethic to relate standard terms used in the literature on engineering education to the concept of SPD situated in the scholarship of community psychology. Section 2.7 will provide greater detail into critical consciousness, SPD, and how it relates to engineering training. First, the following sections discuss how engineers engage with SPD.

The next three sections will view literature in engineering education that reveals insights into the SPD of engineers: Professional Engineers, Engineering Students, and Black Engineers. Then the following sections will focus on scholarship in youth development and community psychology that describes the nature of SPD.

Table 1. Review of Terms in Engineering Education Related to SPD

| Term | Definition |
|-------------------------|--|
| Civic/Public Engagement | <p>Various volunteer, outreach, and service activities in which students elect to participate (Reddick et al., 2018);</p> <p>Civic/public engagement tends to deal with apolitical responses to the inequitable distribution of power and capital in a society. Civic/public engagement includes philanthropic giving, volunteering, public artistic expression, or working collaboratively to solve a community problem. Without specifically calling out social inequities and their influence on the problems address, this could be considered an apolitical and neutral response.</p> |
| Social Responsibility | <p>A commitment to a socially just, equitable and sustainable (Pritchard & Baillie; 2006); a collective responsibility to improve the lives of people around the world, and should contribute to the building of a more sustainable, stable, and equitable world (Amadei; 2004)</p> |

| | |
|----------------------------------|---|
| Critical Consciousness | Refers to an individual’s awareness of oppressive system forces and a sense of efficacy and engagement in action against oppression (Heberle and Rapa, 2020). |
| Political engagement | A consideration of how power shapes social life (Niles, Roundbari and Contreras, 2020) |
| Equity Ethics | A moral concern for social justice and the well-being of people suffering from various inequities (McGee & Bentley; 2017) |
| Sociopolitical Development (SPD) | An orientation toward social justice, a motivation to transform sociopolitical inequity in one’s environment, and the development of a healthy sense of self and feeling empowered to exercise one’s agency in the context of structural oppression” (Diemer et al., 2008,p. 318). This is also considered the development of critical consciousness. |

2.3 Reframing Inadequacies of the Field of Engineering

The purpose of this section is to provide a high-level overview of the typical narrative surrounding the engineering profession. According to Karwat et al. (2015), engineers constantly make political and value claims within the current political, economic, and social structures that depend heavily on technology. However, this narrative surrounding engineering work is often marginalized in the normative narrative of engineering (Downey, 2014). Therefore, insights from this chapter will point to the need for a counternarrative to the typical nature of engineering work.

The typical narrative surrounding engineers in work environments is that they are atypical workers lacking social agency and bounded by the real-work constraints of their bosses and technological environment (Winner 1986; Riley 2008; Cech 2014; Leydens and Lucena,

2018). This results in the belief that engineering's relationship with political, economic, and social systems is often considered irrelevant or neutral.

To provide evidence, Canney and Lambrindou (2018) conducted a study on engineers to stimulate the public's imagination. Participants included first-year and senior undergraduate students, engineering faculty, and engineering professionals with at least five years of work experience outside academia. Engineers were asked to read an article about a conflict in St. Rose, LA, between affected residents, governmental agencies, and industry representatives concerning potential environmental contamination from a local chemical plant. The article presented conflicting views about the facts of the case and left readers with no clear sense of which party was to blame for this technological disaster. The analysis of the narrator responses showed two main reactions. The first was that residents' reported health experiences must have been accurate and that the community's association of these experiences with industrial air emissions, at the very least, deserved attention. The second was that the government and industry interpretations of the monitoring data must have been correct and that the community's reported experiences or explanations must have been invalid. The article provides characteristics of engineers' ideation of the public, which include: (1) the value of scientifically based evidence, (2) artificial separations between views of industry/government and engineers, and (3) starting with belief or disbelief in the community's health claims basing broader judgments about the public and the value of other knowledge on that belief. This work highlights some of the biases and predispositions that engineers utilize when evaluating complex situations and how those biases and preconceptions play a crucial role in filling in gaps in knowledge when drawing significant conclusions that profoundly affect people's lives.

The development of engineers' political, social, and civic responsibility is essential due to the ways the field of engineering is positioned in society. In this paper, Karwat et al. (2015) reflect on the current notions of engineering practice by evaluating the motives for engineered solutions to the ongoing climate change disaster. Responses to ongoing disasters (i.e., climate change and environmental injustices) that rely solely on technological solutions do not account for the social, political, and cultural aspects surrounding challenges. Engineering is not siloed from politics, social hierarchy, or inequalities; neither is the nature of engineering work. Without critical reflection on societal inequities, engineers will continue to uphold normative standards of marginalization, oppression, exploitation, and dehumanization of groups (Semmes, 1995; Karwat, 2019).

The narrative surrounding commonly held beliefs of engineering work will be challenged by counternarratives of Black engineers' perspective of engineering practice. The typical narrative surrounding engineering work does not account for socially conscious marginalized engineers who have incorporated an analysis of their biases. The following section will discuss how shortcomings in the narrative of engineering work could be better addressed.

2.3.1 Discussion of Shortcomings in the Engineering Field

The typical engineering work narrative is limiting when it does not account for identities outside the dominant cis-gender, heterosexual white male. There is extensive literature on broadening participation in engineering that focuses on expanding engineering identity to include experiences of various genders, races/ethnicity, sexualities, and backgrounds (e.g., Holloman et al., 2021; London et al., 2019; Morton, 2019; James & Singer, 2016). However, few scholars in the sub-field of broadening participation in engineering account for how engineering work will

need to be expanded to include diverse identities. This section will briefly identify the shortcomings of broadening engineering practice beyond purely technical aspects and highlight the benefits of this work to diverse engineers.

As the engineering field broadens participation, there is a need to incorporate how marginalized engineers conceptualize engineering work and expand the definition of engineering work to include marginalized identities. For instance, Faulkner's (2009) studies on 'gender in/authenticity' reveal how the nature of engineering work centered on stereotypical asocial men makes women visible outcasts in the field. The separation of technical and social realms of engineering creates gendered engineering work culture elements when women are brought into a male-dominated field. Furthermore, the notion of in/authenticity can be expanded to incorporate the impact of race on white-dominated engineering spaces (Douglas et al., 2019; Dietz et al., 2019). Insight from racial in/authenticity highlights the effects of historically oppressive systems that exist in the ways we do engineering and encourages the engineering field to consider the experiences of racially marginalized engineers placed in this work environment.

Broadening engineering practice beyond purely technical problem-solving enables engineers to develop critical consciousness and potentially act more ethically. Scholars such as Litchfield and Javernick-Will (2015) and Adams et al., (2011) have highlighted how developing critical consciousness through social-technical interactions could potentially increase diversity in engineering. For example, Litchfield and Javernick-Will's (2015) mixed-methods study on socially engaged engineers found that engineers participating in Engineering Without Borders have broader interests and motivations for engineering work compared to non-members. Utilizing a multiple perspectives methodology, Adams et al. (2011) map an innovation landscape for what it means to engage future engineers with epistemological development and social justice

innovations. The benefits of expanding the nature of engineering work include remaining relevant to diverse engineers and addressing complex challenges in society.

Unfortunately, within engineering practice, there is limited knowledge of how marginalized engineers identify with the engineering field once they receive a bachelor's degree in engineering (Douglas et al., 2019; Dietz et al., 2019). Ross (2016) explored the experiences of Black women engineers in the workplace and found that identity, self-awareness, agency in social-integration and activism does influence the retention of Black women. However, we do not know if the white male-dominated engineering field limits how Black engineers can show up as their authentic selves within their engineering praxis. Specifically, we know that Black engineers are motivated by social justice aims and that there are specific barriers in engineering education that result in minimal progress for developing socially conscious engineers (Naphan-Kingery et al., 2019). The next section will expand upon the challenges of preparing engineers for equity-oriented challenges.

2.4 Reframing the Inadequacies in the Preparation of Engineers

Ideally, engineering education would prepare engineers to be socially aware of their professional and ethical obligations, but studies on the development of engineering students' interest in public engagement reveal a concerning decline in social awareness. Generally, research examining large datasets has shown that undergraduate engineering students are less likely than undergraduate students in other fields to believe that an individual can change society, to describe themselves as socially concerned, or to engage in promoting racial understanding or social action (Astin, 1993; Sax, 2000). These findings raise concerns about the training of engineering students. Therefore, this section will zoom in on the preparation of

engineers and present insights from studies investigating the presence of SPD in engineering students.

The findings of the scholars seeking to essentially understand the processes by in which engineering students address social and ethical implications point to this tension between engineering and social justices related topics. For example, using a tentative theory, the Model of College Student Political Identity Development, Morgan et al. (2019) conducted a case study to explore how engineers navigate political identity development. Morgan et al.'s (2019) results reveal tensions that shape their political involvement, including limiting exposure to motivating political events, privileging private gain, and political positioning at engineering borders. Additionally, Niles et al. (2020) conducted interviews and ethnographic observations of program events, classes, presentations, and social groups at two engineering programs focusing on engagement with public welfare and emphasizing learning about the social context and social impacts. Niles et al.'s (2020) results reveal that the main areas where engineering students experience difficulty engaging with considerations of public welfare are (1) defining and defending their identities as engineers; (2) justifying the value of non-technical work and relevance to engineering; (3) redefining engineering expertise and integrating community knowledge into projects; and (4) addressing ambiguous questions and ethics. As I study SPD in the lived experiences of engineers, I must recognize how the context of engineering environments serves as an inhibitor or barrier to engineers' SPD.

Research investigating SPD over time reveals concerning outcomes for engineering students through their training. For instance, Cech (2014) conducted a longitudinal survey study on engineering students' beliefs concerning the public, and the results reveal a decline in students' public welfare considerations as they navigate engineering education. I will center

Cech's (2014) study as evidence because it is the only study in this review that utilizes quantitative measures of the same group of engineering students over four years. It provides greater insight into the context of an engineering discipline in higher education and can make direct inferences about the decline in SPD to the nature of engineering training.

Cech's (2014) work highlights the phenomenon of a collective decline in social awareness, referred to as a "culture of disengagement," to describe collective beliefs, meanings, and practices surrounding engineers' conceptualization of their professional responsibility amidst public welfare concerns. The decrease in students' social consciousness varies across gender, race/ethnicity, university context, and family income. From these results, Cech (2014) argues that the exclusion of public welfare in engineering has been maintained by three ideological pillars: technical/social dualism, individual meritocracy, and depoliticization. Technical/social dualism refers to the hierarchical separation of technological and social concerns, where technical problems are privileged over social. The culture of individual meritocracy refers to the fallible belief that success is derived from individual efforts, which are disconnected from systems of privilege and oppression. Finally, the ideology of depoliticization refers to the idea that engineering can be and should be separated from meaningful considerations of power and social justice. These ideological pillars are barriers to Black engineers' SPD, and this dissertation study investigates how engineers are able to engage in engineering practice and social justice despite inadequate preparation.

As scholars investigate how engineers engage in social justice, research outcomes reveal essential differences in STEM students' social justice values by race/ethnicity (Garibay, 2015; Garibay, 2018). More specifically, studies have shown that Black and Latinx students often negotiate social justice values and motivate interest against the dominant engineering culture that

devalues these concerns. Research on SPD has led me to question how minoritized students develop their social relations without critical departmental/disciplinary support (McGee and Bentley, 2017; Newman, 2011; Charleston, 2012). Furthermore, it reveals a gap in understanding of how engineers with an inclination towards social justice situate themselves in engineering.

Generating momentum for socially conscious engineering practices requires reforms in how engineering students are taught. However, gaps in this literature review point to how social consciousness develops throughout engineering training. Engineering education scholars have attempted to make changes to engineering practice to address social inequalities and receive resistance due to the ideological barriers in engineering culture. For example, the “engineering for good” model dedicates engineering solutions to underserved populations over the normative narrative of engineering work of financial profit and technological efficiency (Kleine & Lucena, 2021). However, these engineering models are likely to receive resistance due to engineering cultures built on the ideological pillars of technical/social dualism, meritocracy, and depoliticization, as Cech (2014) identified.

Efforts to address the social/technical dualism within engineering have been made by reframing engineering as a socio-technical field; however, Niles, Roundbari, and Contreras (2020) argue that up to this point, it is not enough to address only the social-technical dualism in framing the engineering field as a socio-technical field. Both social justice and political engagement are essential in understanding how engineering paradigms can meaningfully engage with the social elements of engineering. Within this critique, they advocated for specific engagement with “the social” to include political engagement and social justice throughout the engineering field. Incorporating political engagement would draw attention to how power inequalities shape the engineering profession and practice. At the same time, social justice

elements would focus on how social conditions are shaped by complex systems of privilege and oppression rather than individual efforts or character. Unfortunately, we are limited in understanding how to successfully incorporate depoliticization and individual meritocracy as critical components in the preparation of engineers (Riley, 2008). The dissertation study explores incidents in marginalized engineers' narratives that resist the ideological pillars in the engineering "culture of disengagement" so that we can better prepare engineers to address contemporary challenges.

The old paradigm of engineering education that primarily frames engineering as purely technical is slowly being replaced by new forms of education based on the "new engineer" (Beder, 2014; Pawley, 2009). This more expansive and critical engineering paradigm considers the values embedded in technology and asks essential questions about who benefits and suffers through engineering practice related to capitalism, industry, military, and the environment (Winner, 1980; Riley, 2008; Cech, 2014; Leydens and Lucena, 2018). Reforms over time were designed to make engineering attractive to potentially diverse students and students more appealing to the job market through the development of leadership and public speaking skills (Trbušić, 2014); however, these reforms have yet to reach their intended impact.

In this review, I will highlight how there have been attempts to incorporate social awareness in engineering preparation. The subsections will review engineering education's success in reframing engineering as a socio-technical field, discuss its inadequacies, and position the success of Black engineers as a significant literature gap in SPD. First, section 2.4.1 will center on strategies used to reform education and present critiques of these methods. Then, section 2.4.2 will position Black engineers as exemplary engineers who have successfully incorporated social elements in engineering paradigms due to their lived experiences.

2.4.1 Discussion of Shortcomings in Engineering Education

The reforms and critiques on engineering being reframed as a social-technical field are essential as engineering educators consider the development of critical consciousness.

Holistically, engineering education has attempted to reframe engineering as a socio-technical field. However, these attempts have promoted a shallow understanding of how engineering praxis can impact society's economic, political, and social structures. This section will present the impact of strategies offered by engineering stakeholders (e.g., accreditation agencies and engineering outreach) and offer critiques of these methods.

Curriculum reform efforts are evaluated by engineering accreditation agencies (e.g., ABET), which play a critical role in framing the values of engineers. Accreditation policies focusing on ethics have increased students' awareness of their role in communities and how they engage with the public. For example, studies before the EC2000 showed that undergraduate engineering students did not perceive the importance of learning about the engineer's role in society (Peters, 1998). However, following the introduction of the EC200, graduates reported higher ability levels on the outcomes related to the awareness of the impact of engineering decision-making and ethics (Lattuca et al., 2006). The current ABET accreditation criteria require that engineering programs must demonstrate that students receive "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context" and show "an understanding of professional and ethical responsibility" (ABET, 2022). The changes in criteria reveal the impact of reforms on engineering paradigms that seek to include social elements in engineering.

As ABET criteria have added new criterion to their assessment, they enable new paradigms in which engineers are able to situate their practice. For instance, engineering education has begun incorporating culturally responsive (or relevant) pedagogy and liberatory education models that focus on enhancing inclusivity and fostering critical consciousness (Castaneda and Mejia, 2018). Also, new engineering models, such as the “humanitarian engineer” and “activist engineer,” have sought to train engineers on environmental and social issues so that the social elements do not ignored in engineering practice (Conlon, 2008; Conkol, 2012; Karwat, 2019). Focusing on social issues in new engineering paradigms can shift what counts as “real” engineering towards practices that foster public good and more equitable social conditions (Harris et al., 2013).

Unfortunately, reform efforts and new engineering models fail to prepare engineers to develop equity-oriented solutions. For instance, Engineers Without Borders (EWB) is one of the most prominent educational outlets for socially engaged engineers; however, the outreach opportunities are racially and internationally divided (Stine et al., 2022). EWB is almost entirely hosted by predominantly white institutions (Howard University being an exception), and there is limited engagement with low and middle-income countries. Without understanding connections and avenues for marginalized engineers to engage in communities of their own, we will continue to have a limited understanding of the ways marginalized engineers are prepared to address social inequities. This gap in literature motivates the need to explore the pathways of marginalized engineers engaged in equity-oriented efforts.

Current reform efforts in engineering education have been exclusive of engineers of color who conceptualize how engineering praxis can impact the economic, political, and social structures in society. This results in a shallow understanding of ethical concerns that prohibit the

development of engineers' social consciousness. Critiques offered by Bucciarelli (2008), Perez-Colón (2008), and Beder (1999) emphasize that we must go beyond reform in engineering education to incorporate social-technical implications in engineering practice. For instance, Bucciarelli (2008) refers to the reforms offered by engineering accreditation as artificial. He makes this evident by using the example of teaching surrounding engineering ethics that utilizes fake scenarios. He explains how it does very little to prepare students for real-world scenarios. He states, "Ethics ought not to be neglected in engineering education, but more fundamental and prerequisites for students to learn about the social, the organizational – even the political – complexities of practice" (p. 141). This critique views the past reform efforts as minimal progress and motivates critical actions to make effective changes in engineering training.

In contrast, Perez-Colón (2008) and Bedar (1999) agree that positive changes have been made in incorporating non-technical content through reforms and strategies. However, the narrow focus on leadership, productivity, efficiency, and management disregards the need to develop consciousness of the role engineering has in communities of color. Perez-Colón (2008) advocates for the need to incorporate social responsibility in engineering education for students to fully understand the social context of their work and utilize critical consciousness to address social inequities. The following section will position Black engineers as examples of individuals who successfully integrate social justice and engineering practice.

2.4.2 Positioning Black Engineers' Careers as Exemplars

This section aims to position Black engineers' careers as examples of engineers integrating social justice into an engineering paradigm. This does not mean that Black engineers are the only engineers nor that all Black engineers desire to address social inequities through this

work. However, research on Black engineers' critical consciousness emphasizes how they lived experiences surrounding Black engineers in society correlate to a higher chance of SPD.

Therefore, this subsection will present insights from research that investigated the experiences of Black engineers and relate these insights to the dissertation study.

Building upon Ebony McGee and Bentley's (2017) work, my dissertation study is related to the development of equity ethics in Black engineers. McGee & Bentley (2017) highlight how Black engineers are more likely to develop a critical motivation called 'equity ethic'. They define equity ethic as a "principled concern for social justice and for the well-being of people who are suffering from various inequities" (p.6). The equity ethic framework is grounded in research on STEM undergraduate students of color, doctoral students, and postdoctoral scholars (Garibay, 2018; McGee et al., 2016; Gibbs & Griffin, 2013). The conceptual framework of equity ethics highlights the multiple reasons individuals with marginalized identities are motivated by the need to address social inequities in their paid careers or voluntary acts of service.

The first reason I will highlight is that their experiences of marginalization (e.g., stereotypes, spirit murdering, and marginalization) motivate Black engineers to be actors of change and improve communities in need. Naphan-Kingery et al.'s (2019) explored the relationship between doctoral engineering and computing students' experiences with social suffering, equity ethic, and career interest. The results revealed that students with a high equity ethic personally experienced or witnessed social suffering within and outside of academia. This research questions the specific incidents and context within Black engineers' narratives that cultivate SPD. Unfortunately, research shows that Black engineers' experiences with social suffering led to greater empathy and responsibility to respond. However, there is a gap in

knowledge on how this social suffering influences the process of SPD and which critical incidents influence the motivation towards social justice in their engineering practice.

The second reason is that the collectivist cultural background makes people of color value contributing to groups and prioritizing the group over the individual. In a more recent article in this scholarship, McGee et al. (2020) highlight how some Black people consider their individual experiences as tied to the success of the entire race. Due to this critical awareness that may emerge in Black engineers engaged in disaster management, this dissertation study seeks to illustrate an in-depth understanding of the process by which Black engineers come to the place of critical motivation and action. I hope that by understanding this process, the engineering education field could leverage the experiences of engineers of color and incorporate their viewpoints in reframing engineering paradigms.

Black engineers' narratives could potentially inspire the value and utility of integrating SPD in engineering education. For instance, Mcalister et al. (2020) utilized transformational resistance and engineering identity to explore ways that engineering identity, social identity, and identification with social justice may be co-developed. A single case study methodology examines the counternarrative of Andre, an Afro-Latino male undergraduate computer engineering student who took an engineer that integrates issues of racial inequality. In this study, they discovered that his experiences as a Black person caused him to have a personal connection to his critiques of social oppression, and he learned that he might have agency in working towards social justice through engineering. The results highlight the value and utility of integrating issues of social inequality into engineering education to increase interest, persistence, and representation in the field of engineering.

While the work on equity ethic has provided the evidence and motivations for Black engineers' desire to incorporate social justice, I will use an SPD framework to understand Black engineers' narratives of addressing social inequities. This framework is helpful because it describes the process of individuals incorporating a social analysis within their praxis. Therefore, in the context of this study, SPD illustrates the levels of critical consciousness as individuals demonstrate an interest in civic/social responsibility, civic/public engagement, equity ethic, and/or political engagement. I will provide more details about the theories and research surrounding SPD in section 2.7.

2.5 Summary of Literature Gap

This literature review has presented significant insights into the literature gaps this dissertation addresses. The critical literature gaps are as follows:

1) There are limited narratives of engineering work that account for diverse engineers.

The typical narrative surrounding engineering work does not account for socially conscious marginalized engineers who have incorporated an analysis of their biases. The engineering work narrative is limiting when it does not account for identities outside the dominant cis-gender, heterosexual white male. Few scholars in the sub-field of broadening participation in engineering account for how engineering work will need to be expanded to include diverse identities.

2) There is a limited understanding of how to best integrate social justice elements in engineering practice.

We are limited in understanding how to best successfully incorporate depoliticization and individual meritocracy as critical components in the preparation of engineers (Riley, 2008). Therefore, the dissertation study explores incidents in marginalized engineers' narratives that resist the ideological pillars in the engineering "culture of disengagement" so that we can better prepare engineers to address contemporary challenges.

3) *There is a limited understanding of Black engineers' professional identity beyond the university context.*

Within engineering practice, there is limited knowledge of how marginalized engineers identify with the field of engineering once they receive an undergraduate engineering degree (Douglas et al., 2019; Dietz et al., 2019). Ross (2016) explored the experiences of Black women engineers in the workplace and found that identity, self-awareness, agency in social-integration and activism does influence the retention of Black women. However, we do not know if the white male-dominated engineering field limits how Black engineers can show up as their authentic selves within their engineering praxis. Specifically, we know that Black engineers are motivated by social justice aims and that there are specific barriers in engineering education that result in minimal progress for developing socially conscious engineers (Naphan-Kingery et al., 2019).

4) *There is limited understanding of how Black engineers' SPD manifests over time.*

As scholars investigate how engineers engage in social justice, research outcomes reveal important differences in STEM students' social justice values by race/ethnicity (Garibay, 2015; Garibay, 2018). More specifically, studies have shown that Black and Latinx students

often negotiate social justice values and motivate interest against the dominant engineering culture that devalues these concerns (Ross, 2016). The results question how minoritized students largely develop their social concerns without critical departmental/disciplinary support (McGee and Bentley, 2017; Newman, 2011; Charleston, 2012). Furthermore, it provides a gap in understanding of how engineers with an inclination towards social justice situate themselves in engineering work.

These literature gaps have provided significant insights into this study's purpose, reiterated in the following section.

2.6 Purpose of Study

The purpose of this multiple case narrative study is to explore the process of sociopolitical development within five Black engineers' narratives who are inspired to address social inequities through their engineering work. Research on SPD in engineers will provide insight into how engineering stakeholders influence the cultural values underlying the nature of engineering work throughout the multiple settings of Black engineers' career development. The overarching research question is: How does the SPD process unfold through the career narratives of Black engineers? Sociopolitical development (SPD) can be defined as "an orientation toward social justice, a motivation to transform sociopolitical inequity in one's environment, and the development of a healthy sense of self and feeling empowered to exercise one's agency in the context of structural oppression" (Diemer et al., 2009, p. 318). In answering these research questions, this study will explore how Black engineers narrate their awareness and experiences through engaging in engineering practice to understand SPD in engineers.

2.7 Theoretical Foundation

The theoretical foundation of this study is critical consciousness, which provides the principles of SPD. My contribution to engineering education literature will be applying a theory utilized in community psychology to describe the development of Black engineers' critical consciousness. This section will first describe critical consciousness and its foundational roots, and then the next section will map the developmental literature on SPD. Lastly, I will present two models of SPD that are useful to the purpose of the study and synthesize the model for optimal usage in the research design.

2.7.1 Critical Consciousness

Before explaining how SPD can be applied to engineering education and practice, I must first describe critical consciousness (CC) and its components, because CC is the foundation of SPD. As a reminder, CC describes an individual's awareness of oppressive system forces and a sense of efficacy and engagement in action against oppression (Heberle and Rapa, 2020). Developing this skill is essential to address the three ideological pillars of the culture of disengagement (technical/social dualism, individual meritocracy, and depoliticization) within engineering and practice. Most specifically, critical consciousness can directly address individual meritocracy and depoliticization, which is not addressed when reframing engineering as a socio-technical field. Critical consciousness centers on social justice and political engagement through multiple trajectories, and I am seeking to explore how it develops Black engineers' narratives.

The conceptualizations surrounding critical consciousness (or conscientização) emerge from the writings and pedagogical practices of Paulo Freire (1973, 2000). Freire's collaborative teaching methods for poor, illiterate Brazilians created the foundation for critical pedagogy and

thought. His methods encouraged individuals to think critically about political and social injustices maintained by oppressive systems and advocated for eradicating illiteracy. Freire believes a critical understanding of social and economic inequities is a pre-condition for disadvantaged people to address inequities effectively. Consideration of inequities can include poverty, economics, racism, oppression, and disasters. Furthermore, Freire believed that becoming aware of social and economic inequities and their root causes will equip individuals to act within (i.e., resist or transform) oppressive systems that alleviate society's social and economic injustice. He describes critical consciousness as consisting of two components (i.e., reflection and action) that focus on transforming social systems and conditions. Contemporary, critical consciousness has informed numerous theoretical frameworks and studies globally in education and community psychology by expanding upon these components.

Building upon Freire's (1973, 2000) work, scholars that sought to incorporate CC in research have conceptualized CC as consisting of three components: (1) critical reflection or engagement in critical analysis of inequality, (2) political efficacy (sometimes referred to as critical motivation) or perceived capacity to affect change and (3) critical action in activities intended to affect change (Heberle et al., 2020; Watts, Diemer, and Voight, 2011). Because Freire did not provide a precise conceptual framework for CC, modern conceptualizations have varied in their emphasis on reflection, motivation, or action (Diemer et al., 2016). Within this dissertation study, I characterize CC as a developmental asset that incorporates the three central components of CC and may potentially promote empowerment. The development of CC is referred to as sociopolitical development (SPD).

2.7.2 Introduction to SPD

As I seek to build upon the work on SPD, it will be challenging to understand its central foundation when scholars are also trying to develop a clear consensus on what CC encompasses. Scholars have sometimes interchanged CC, SPD, and empowerment (Christens et al., 2016). Although CC emphasizes the cognitive aspects of SPD more than empowerment's emphasis on the emotional aspects, both have been theorized as overarching conceptual frames spanning SPD's emotional and mental aspects. For instance, Brookins' (1999) examination of liberation and community psychology from a Black-centered perspective reframes the general definition of empowerment so that it is specific to Black Americans' historical experiences. His review found two central themes in the empowerment construct: race consciousness and self-actualization. Therefore, for Black Americans and others that experience oppression, the process of understanding social and political elements of society means a specific understanding of racial and cultural elements. To ensure alignment, I offer the advantage of centering the work on disaster management and on the history and cultural experience of Black engineers to illuminate how their views on social and political elements surrounding the nature of engineering work may differ from their colleagues.

Scholarship on SPD has been more ecologically oriented and has incorporated critical consciousness more broadly in education and career outcomes (Watts et al., 2003; Watts et al., 2011). SPD is useful for examining how Black engineers narrate their engineering praxis on addressing social inequities because it facilitates attention to the ecological/relational context in which engineers are socialized through CC. For example, one of my narrators described their engineering praxis within the context of collaborating with community activist groups. As he narrated his career journey, he began naming all of the experiences that influenced his desire to

engage in community activism with minimal probing questions. Along the narrative, he mentioned his personal experience with affordable housing highlighting the intrapersonal context that developed a deeper understanding of inequities. As he pursued an engineering degree, he knew he wanted a space to improve housing infrastructure given his parents' experience. However, as he engaged with engineering community engagement groups, he discovered engineering solutions are not always the best solutions when there are underlying social challenges. With this new awareness, he demonstrates restraint and asks equity-oriented questions before implementing engineering solutions. If coding for the existence of CC, all I would need to understand is that they began to ask questions. However, by analyzing the process of CC, I would recognize CC is ongoing, and I will need to understand what experiences ignited their interest along with their socialization in engineering culture and beyond. The role of social context and significant life experiences is described by Martín-Baró (1994) as a synergistic relationship between practice and reflection.

SPD scholarship has focused on understanding critical consciousness and its roles in youth development and civic engagement (Watts et al. 2011); however, this analysis can be expanded further into professional development. By illustrating the process and context in which Black engineers develop the motivation to address social inequities that arise amidst disasters, engineering education could better understand how to incorporate social justice in engineering paradigms from a marginalized perspective.

2.7.3 Models of Socio-Political Development

Within this literature review, I will highlight the applicability of the Theory of Transformative Consciousness (Jemal, 2018) as a conceptual model of SPD. The Theory of

Sociopolitical Development is a psychological stage theory constructed by Watts and Abdul-Adil (1998) and based on work by Serrano-Garcia and Lopez-Sanchez (1992) and Ander-Egg (1980). This theory helps understand the conditions and context in which SPD is developed and provides opportunities for comparative analysis across individuals' narratives. Building upon this work, Jemal (2018) presents a conceptual model of Transformative Consciousness (TC) to conceptualize, operationalize and describe the development of CC. TC is also a staged process theory, but it is expanded further to include domains of awareness, behavioral response, and perceived consequence according to each level of the socio-ecosystem. This conceptual model can be applied to various social issues observed by individuals and helps apply to the multiple case narratives collected in this research design process.

The conceptual models presented by Watts and Abdul-Adil (1998) and Jemal (2018) have been used in various applications. For instance, Watts et al. (2003) utilized the Theory of Sociopolitical Development to analyze the narratives of Black activists in New York City, Chicago, and San Francisco Bay between 16-35 years old. Through a transactional approach, memorable experiences were used as a unit of analysis and resulted in trajectories of SPD. These trajectories can be further grouped into common themes such as city government, human services, community organizing, or political ideology if needed. I will utilize Jemal's (2018) conceptual framework due to its clear description of SPD elements that I can expand further in the application process.

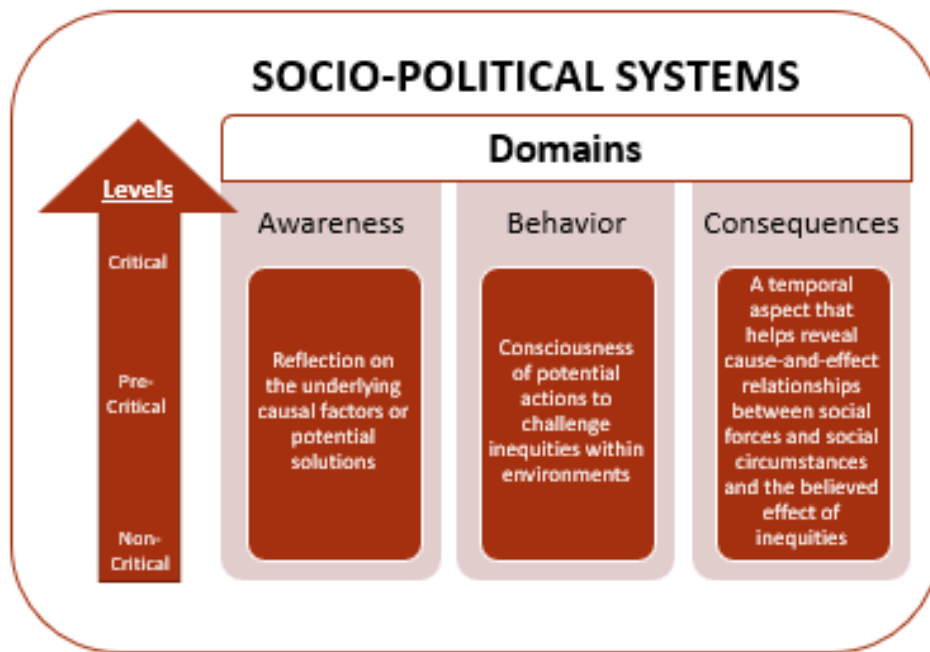


Figure 1. Conceptual Framework of Transformative Consciousness Development (Adopted from Jemal, 2018)

Jemal’s (2018) Theory of Transformative Consciousness’s a priori codes are useful for analyzing the narratives given its specific extension of analysis in TC levels, stages, domains (e.g., awareness, behavioral response, and consequence of consequences) and socio-ecosystem levels. Jemal (2018) conceptualized SPD as the Theory of Transformative Consciousness with three levels and six stages presented in Table 2. Level 1 is a non-critical level composed of two stages. In stage 1, referred to as unquestioned belief, the individual takes what they believe as what they know, and the knowledge is without question. In stage 2, referred to as discovery, the individual experience conflict, anger, resistance, and doubt around their consciousness. Level 2 is precritical and contains two stages as well. In stage 3, referred to as duality, there is a strong use of system justification and cognitive dissonance to retain the original belief system while

simultaneously not rejecting the conflicting belief system. This individual may also recognize the lack of evidence supporting current perspectives but may feel that certain beliefs cannot be changed. In stage 4, referred to as contemplation, the person differentiates between views and determines which ideas to keep and which to discard. This stage is also characterized by nostalgia for the old belief system. Finally, level 3, TC is composed of two stages. In stage 5, referred to as integration, individuals accept ideas that would have been completely overlooked in stage 1. The individual recognizes the usefulness of previous strategies in consideration of new ideas. Lastly, at stage 6, referred to as liberation, the individual may begin to practice action under newfound beliefs, reinforcing and allowing new beliefs to replace old ways of thinking.

Table 2. *Stages in Transformative Consciousness Development (Adopted from Jemal, 2018)*

| Level | Stage | Definition |
|-----------------------------------|------------------------------|--|
| Level 1: Non-critical/ denial | Stage 1: Unquestioned Belief | The individual takes what they know as all-being and beliefs are unconscious and automatic. Information that confirms beliefs system is automatically accepted and never questioned. The subconscious mind generates resistance when retained information and knowledge from past experiences conflict with the new information and/or experience being presented. |
| | Stage 2: Discovery | The individual develops a consciousness of conflicting perspectives usually precipitated by confrontation or challenge. |
| Level 2: Precritical blame/credit | Stage 3: Duality | The individual attempts to find ways to hold countering beliefs while struggling to maintain pre-existing beliefs in the face of contradicting information or experience. |

| | | |
|---------------------------------------|---------------------------|--|
| | Stage 4: Contemplation | The individual begins to recognize that their beliefs had a beginning and can also have an end. |
| Level 3: Critical consciousness | Stage 5: Integration | The individual develops an attitude of complacency regarding the conflict and asymmetry of consciousness. Individuals integrate new and old ways of thinking that inform action. |
| | Stage 6: Liberation | Based on the integration of new and old ideas and micro and macro factors, the individual can discern the roots of their thinking and the factors influencing consciousness. |

Jemal's (2018) model also adds layering of analysis by incorporating Bronfenbrenner's (1989) Social-Ecological Systems Theory as shown in Table 3. This theory explains that individual and environmental factors are interrelated. Individual narratives are situated in their contextual environment, and contextual environments influence individual behavior and development. This framework is particularly useful in the multiple case narrative as the individuals' differences in experiences and perspectives are highlighted as I explore their sociopolitical processes. It is essential to capture the socio-ecological aspects of the Black engineers' narratives within the dissertation study because inequity is conceptualized through multiple systems, including the individual, institutions, and cultural norms. This model helps identify the contextual factors and relationships between self, others, and the broader community. The following section will explain how combined conceptual models can provide a theoretical foundation for dissertation research design.

Table 3. Definitions of socio-ecosystem levels (Adapted from Jemal, 2018)

| Socio-ecosystem levels | Definition |
|-------------------------------|--|
| Intrapersonal | Pertains to the self; includes the process that exist within a person (e.g., internal thoughts, attitudes, emotions and beliefs) |
| Interpersonal | Includes all interactions between individuals |
| Microsystem | Includes interactions between groups of individuals closely related to an individual |
| Mesosystem | Includes interactions between different parts of a person’s microsystem (e.g., family, schools and jobs) in which the microsystem exert influence upon each other |
| Exosystem | Includes interactions between institutions in which the individual plays no role in decision making process, but it has a direct or indirect impact on the individual level |
| Macrosystem | Includes sociopolitical environment, culture, norms, values, laws, attitudes, and ideologies |
| Chronosystem | The patterning and cumulative effects of events and transitions manifesting overtime or through the individual’s narrative along with socio-historical circumstances shape the individuals context |

Scholarship on SPD has been more ecologically oriented and has incorporated critical consciousness more broadly in education and career outcomes (Watts et al., 2003; Watts et al., 2011). Therefore, as I build upon the work on SPD, I must maintain the context of participants’ narratives. In this study, SPD is useful for examining how Black engineers narrate their engineering praxis on addressing social inequities because it facilitates attention to the ecological/relational context in which engineers are socialized through CC. By illustrating the process and context in which Black engineers develop the motivation to address social inequities

that arise amidst disasters, engineering education could better understand how to incorporate social justice in engineering paradigms from a marginalized perspective.

2.8 Summary

In this chapter, I have provided an overview of literature related to the ways engineers seek to address social inequities and the background of the conceptual frameworks I attend to use. Insights from with review will be helpful in the ways I explore the development of socio-political analysis in addressing social inequities. In addition, insights from this chapter are critical for the research design in Chapter 3.

3. Chapter 3: Research Design

3.1 Introduction

The purpose of this multiple case narrative study was to explore the process of sociopolitical development within five Black engineers' narratives who are inspired to address social inequities through their engineering work. The research design and adapted SPD framework (Jemal, 2008) enabled the exploration of how Black engineers narrate their career trajectories to incorporate social justice into engineering to understand sociopolitical development in engineers.

As shown in Chapter 2, a significant limitation of previous studies on SPD in engineering education is that a university context bounds it and does not account for racially minoritized engineers. Multiple case narratives enabled me to collect the career journeys of Black engineers using narrative inquiry and analyze the stories according to the case bounded by the time their sociopolitical inclinations begin to where they are in the present. The narratives collected in this research serve as this counter-narrative of the atypical engineer. The overall research question is: *How does the SPD process unfold through the career narratives of five Black engineers?* The sub-questions are:

RQ1: What events depict the trajectory of Black engineers' sociopolitical development (i.e., career narratives) focused on disaster management?

RQ2: How do SPD elements manifest in career narratives?

RQ2a: How do SPD domains and levels show up in career narratives?

RQ2b: How do they move through the SPD elements throughout their careers?

RQ3: What sociopolitical (socio-ecosystems) systems shape the SPD?

In order to answer these questions, I designed this research study in three phases: 1) Narrative Construction, 2) Narrative Refinement, and 3) Cross-Case Analysis. The narrative construction phase focuses on identifying cases and constructing narratives. Next, the narrative refinement focuses on identifying critical incidents within the narrators' SPD plots and verifying them through multiple drafts. Lastly, the cross-case analysis phase focused on comparing SPD elements across all SPD plots. The final output of the results section is trends in how Black engineers narrate their SPD and situate their SPD in sociopolitical systems. Before I discuss each phase in greater detail, I will first discuss my positionality and why this study was essential to me as a researcher. Then, I will provide an in-depth description of my research design and methods. This includes a description of the narrative-case study methodology, data collection procedures, data analysis process, and quality measures employed throughout the design.

3.2 Researcher Positionality

In this section, I will disclose my positionality using essential components outlined by Hampton et al. (2021). From their research, the main features of a positionality statement consist of disclosing identity, prior experiences/opportunities, and journey to the study. In revealing my positionality at the forefront of my research design, I aim to ensure trustworthiness (a measure of validity and quality). According to Woods (1996), "the researcher's self is inextricably bound up with the research" (p. 51). Therefore, I must bracket my positionality as I conduct narrative research so that my positionality is not bound to the study of my narrators' journey. Hampton et al. (2021) encouraged researchers to "interrogate their identities within structures of power

because the researcher-researched relationship is subject to power dynamics” (p. 126). Therefore, I will first disclose my identity.

3.2.1 Identity

As a qualitative researcher utilizing a constructivist-narrative approach, I must illustrate my position in the research design process as I expound on the methods of this dissertation study. I am a narrative researcher in this study, and my motivations, position, and worldview are essential to the investigation and in-depth descriptions. My role is to understand the narrator’s point of view from an empathic lens. My positionality justifies the choices I explicitly made as I designed this study.

I identify as a first-generation, queer, Black woman. In my journey of navigating multiple identities, I have experienced both physically visible and invisible worlds simultaneously. This experience has led me to believe that everyone experiences the world differently. For instance, my identity has often allowed me to see the world through an intersectional lens. Specifically, my most salient identities in the engineering spaces are my race and gender because I do not have agency over their visibility. My salient identity as a Black woman has always led me to constantly negotiate who I am and how I want to present myself in white spaces.

3.2.2 Prior Experiences and Opportunities

My prior experiences surrounding engineering students, professionals, cultures, and context suggest that male whiteness is the standard of success in our achievements. I went to predominantly white institutions throughout my education, so I found myself sticking out like the proverbial “Black sheep”. As I think about who I am and the researcher I want to be, I want to

highlight experiences in STEM that show how different unique cultures are outside the normative narrative of whiteness given passively to students of color. Sometimes that may mean that I will advocate for policy changes. Other times that may mean that I will tell stories highlighting Blackness' complexity because these are stories I wish to hear. My assumptions highlight that those different ways of knowing, and existence are necessary to advocate for diversity and inclusion in white spaces.

Furthermore, I have been inspired by engineers who work alongside communities with limited resources because I see it as a primary way to help underserved communities. Growing up in two places (suburbs in Columbia, SC, and low-country Walterboro, SC) and excelling in math and science, I saw first-hand the privileges and inequities in different places in SC alone. In Columbia, I took honors/AP courses and attended engineering programs that prepared me for my future. Simultaneously, I found value in my summers with grandma in the low country because she taught me the culture and values of being a southern woman in a small rural town. However, as I navigated these two spaces, I always found myself in the middle, never genuinely belonging. This borderland experience has greatly influenced my research because I now search for people and engineering work within the boundaries of multiple worlds. It is often assumed that social justice and engineering are mutually exclusive, so I strategically look for the space where they intersect.

Essentially, this dissertation study allowed me to use my identity, motivation for research, and communities I am a part of as my measurement for success, so I have chosen to focus solely on Black communities. My position comes from a place of care and concern for my dissertation's research topic. Through first-hand experience, I understand there is so much beyond the surface as I research Black people and the terms surrounding their existence. A single

mother from a small rural town in South Carolina, where literature would be considered an ‘underserved community,’ raised me to be who I am today. Long histories of racial tensions attribute the failing infrastructure to remnants of desegregation. To provide me with a better life, my mother moved to the suburbs and worked 3-4 jobs to receive access to quality education. However, this provided privileges that were not accessible to my family members that stayed in rural areas. I noticed how different experiences can be because you live in another county alone. This inequity is something I feel guilty about, and it dramatically impacts my desire to use my research to collaborate with “underserved” communities. Without fully knowing what engineering entailed, I chose engineering as a career because I hoped I could use it as a tool to help others. Sadly, I was mistaken when my engineering training made Blackness and equitable considerations invisible. Therefore, through research, I can search for areas in STEM that address social inequity for personal reasons.

3.2.3 Journey to Dissertation Study

In a public-inspired science talk for the Virginia Tech College of Engineering (2020), I describe my journey and motivations for pursuing a Ph.D. in Engineering Education. In my own words, I stated,

*“As an engineer, I want to understand my own social responsibility
And find comfort with the hidden social scientist inside of me
Now 23, I found a key to new possibilities with my Ph.D.
Disaster resilience and responding to community needs”*

My journey through K-12 to Engineering Education recognizes social inequity as a significant factor influencing my positionality, worldview, and framing of my dissertation study. I research

to explore myself and the world around me. My first step is identifying a need in society. When developing my current study, I aimed to understand how social justice constructs can be applied in engineering practice. These topics are important because as I navigated engineering cultures, I constantly looked for a space where I could see my community influenced by engineering practice. I searched the literature for places where social justice and engineering collide and did not find any examples of how we discuss engineering practice for Black communities in the US.

However, I did note how much scholarship exists on broadening participation that seeks to recruit, retain, and support marginalized groups in engineering. Yet, I rarely found the scholarship on how engineering benefited the communities they seek to recruit. Beyond obtaining social mobility, I sought to understand how Black people could use engineering beyond what is taught in the classroom throughout their personal and professional lives. I landed on a study that asks Black engineering professionals their view of engineering work that addresses social inequities so that I can understand where this work takes place while also amplifying Black voices in engineering education literature.

After I observed Hurricane Katrina, Flint and Denmark's Water crisis, Black Lives Matter, COVID-19, and systemic racism's impact on structural inequalities, it became clear that disasters are the one place where inequity cannot be ignored. In addition, it is a space where engineering work makes significant contributions. Through reviewing the literature on disaster management and engineering education, I believed the essence of addressing social inequities was a gap in the literature for each body of knowledge, so I chose this as my topic. Within the engineering field, I noticed that they attempted to address social inequities in ways that erased the experiences of Black people. Furthermore, as an engineering student, I learned applications

and theories that engineers use in industry and education that further marginalized my peers, elders, and ancestors.

I began a grieving process around receiving my engineering degree because I was afraid that my engineering work would not benefit the people I care most about or, worse, harm the people I care about. I came to research in desperation to find a space that reflects the experiences of people who looked like me and sought to address inequity. In this transdisciplinary space, I found boundary work and hope to add to scholarship that broadens engineering work to consider the need to dismantle systems that breed inequity. Alongside this hope is a desire to design and implement spaces where engineering and design thinking could prioritize marginalized ways of being an engineer and address social inequity.

My biggest fear in doing research is misrepresenting communities. I favor narrative and participatory action methodologies because I value research participants' words, aspirations, and goals over my perceptions. The main topic that interests me is sociopolitical development because I desire to do engineering work with an equity orientation. Blackness is the most salient indicator of marginalization in the US due to intersectional experiences with colonization, race, class, and sexuality. Therefore, I have sought to understand how identity and experiences influence sociopolitical development in engineering work. In the context of this study, I adopted a constructivist-narrative approach that values the ways narrators frame their sociopolitical development in their own words. Therefore, I needed to design a study that allowed me to identify individuals at the cutting edge of engineering and learn from their existing ways as Black engineers who also desire to address inequity in various avenues.

In the next section, I will elaborate on my choice to use a multiple-case narrative to manage my desire for a narrative-constructivist approach to the research design.

3.3 Multiple Case Narrative Methodology

Multiple case narrative methodology was selected for this dissertation study because it merges methods from the narrative (Clandinin & Connelly, 2000) and multiple case studies (Yin, 2002). Narrative methodology captures a narrator's career journey, providing space for various contexts in the narrator's life where SPD emerges, not bounded in time. The narrative inquiry strengthens the research design by exploring how Black engineers make sense of events and actions by eliciting information on the individual and contextual experiences surrounding the adoption of critical consciousness and desires to address social inequities through their careers. However, participant narratives are the outcomes of typical narrative research. In contrast, for this study, the research outcomes are an in-depth description of how SPD emerges in each narrator's career journey. Therefore the narrative methodology takes precedence in the narrative construction phase, and the multiple case study methodology is fundamental in the data analysis phase.

Multiple case narrative provides the freedom of a narrative inquiry and the context necessary in multiple case studies. The multiple case narratives combine the benefits of generalizable, cross-sectional, and in-depth process analysis (Shkedi, 2005). The multiple case study was the primary research analysis process, while the narrative inquiry was the primary data collection process. Utilizing multiple case narratives builds upon instrumental multiple-case study selection and incorporates inductive interpretations. This dissertation is exploratory by

nature and focuses on the inductive interpretations that can be compared to the conceptual model of SPD.

As shown in Chapter 2, a significant limitation of previous studies on SPD in engineering education is that a university context bounds it and does not account for racially minoritized engineers. Currently, work on SPD in engineers is not representative of the multiple context and pathways in which marginalized engineers experience the process of addressing social inequities. For this reason, it is essential to be open to the various contexts within and beyond the university in which engineers develop their critical consciousness over time. In analyzing the process in which participants' experience SPD, a methodology that can investigate the phenomenon under exploration in multiple contexts bounded by individuals' career journeys is well-aligned with the research goals. The outcomes of a multiple-case narrative methodology provide an in-depth description and analysis of the sociopolitical development process in multiple individuals utilizing a narrative inquiry data collection method and a multiple-case study data analysis. In this case, the narrators' career journeys define each case, and the embedded unit of analysis is critical incidents that shape the narrators' career journeys. The following sections will describe the methods employed throughout this research design.

3.4 A Multi-phase Research Design

This section will overview my critical decisions in alignment with the multiple-case narrative methodology design. This research design comprises three components: Phase 1 - Narrative Construction; Phase 2 - Narrative Refinement; and Phase 3 - Cross-Case Analysis. Phase 1 focuses on identifying cases and constructing narratives. Case identification targeted organizations with a large population of Black engineers or engineers interested in disaster

management work. Disaster management work is defined as responses/considerations to socially constructed events that result from the interface of nature, social conditions, and technology that further exacerbate social inequities (Perry & Quarantelli, 2005). In addition, data on each case was collected using an intake questionnaire. The narrator's demographics and measurements of SPD were instrumental in identifying the case requirement for this dissertation study.

Participants that responded to the listserv and flyer posting were asked to recommend other engineers that might be reasonable for the study. Once cases were identified, I conducted narrative interviews documenting each narrator's career journey. These stories were analyzed to understand the structure of each story and how it relates to the process of SPD. The outcome of phase 1 is SPD plot trajectories within the narrators' stories to offer guides to the complete narrative. Next, phase 2 focused on identifying critical incidents within the narrators' SPD plots. Using the critical incident interviewing method, I followed up on the narrative interviews and asked for in-depth descriptions of how their SPD developed. This interview was analyzed using transactional analysis. Lastly, phase 3 focused on comparing SPD elements across all SPD plots. The final output of the results section is trends in how Black engineers narrate their SPD and situate their SPD in sociopolitical systems.

The constructive-narrative approach to a multiple-case narrative encourages flexibility in focus and presents the opportunity to collect various forms of data. To supplement narrators' interviews and gather insight into the context of the individual cases, I utilized an intake questionnaire, LinkedIn profiles, and publicly available information online to understand how sociopolitical inclinations develop, as shown in Figure 3. The intention is to study the phenomena through the eyes of the people who experience them and supplement this knowledge

with the context in which individuals are situated. In the following sections, I will go into greater detail of each phase.

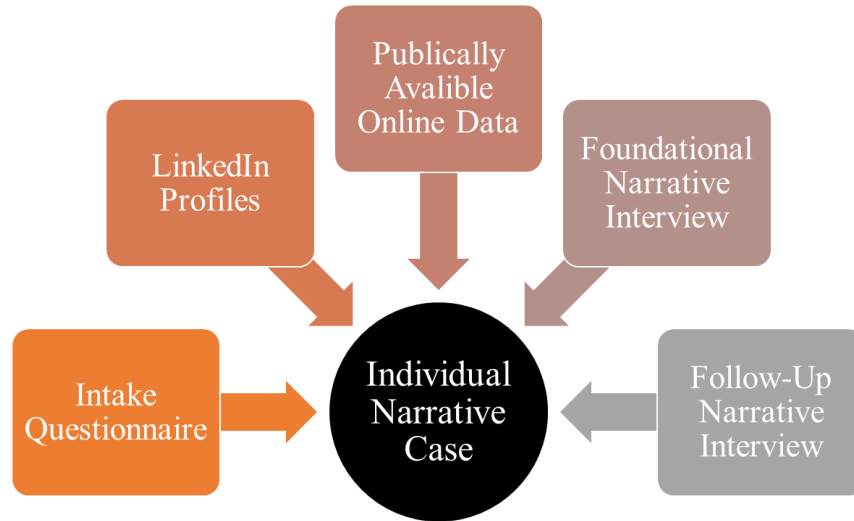


Figure 2. Types of Data Collected

3.5 Phase 1: Narrative Construction

The first phase of this research process centers on identifying cases and constructing narratives of the cases. This phase comprises three components: case identification and selection, data collection, and SPD mapping. I will describe each in further detail in the following sections.

3.5.1 Case Identification and Selection

Starting with case identification and selection, I used purposeful, convenient snowball sampling to recruit narrators by targeted organizations and online platforms with engineers interested in disaster research. Through purposeful sampling, I searched for Black engineers on online platforms highlighting Black engineers doing work that addresses social inequity related to disasters. Following this, I sent individual research invitations (Appendix A) to reasonable participants that may meet my criteria. I sent individual research invitations to participate in the

research study. In addition, I recruited via known organizations with a population of Black engineers and disaster researchers, such as the William-Avertte Anderson Fund (Bill Anderson Fund, n.d.). During recruitment, I kept in mind that I wanted a sample that reflects the heterogeneity of the Black community and does not present a monolithic view of Black engineers' approaches to addressing social inequity and definitions of what social injustice entails. Interested individuals were asked to complete an intake questionnaire.

An intake questionnaire collected specific case details to select a representative sample. In the survey, I collected data on their demographics (gender, educational background, work experiences, and location) along with indicators of their sociopolitical development to identify their current stage in the SPD process. I used specific items from the Critical Consciousness Inventory (Thomas et al., 2014) and the Measure of Adolescent Critical Consciousness (McWhirter and McWhirter, 2016) to measure critical reflection, motivation, and behavior for each narrator. The survey template is included in Appendix B. This information highlights each narrator's sociopolitical development level. In addition, I utilized publicly available data online to gather insight surrounding the individuals' narratives.

Within this sample, I selected three women and two males due to their responses to the intake survey, specifically paying attention to their SPD measurements and description of motivation in work. All five narrators have training in civil engineering and attended graduate school at predominantly white institutions. Furthermore, each case met the following inclusion criterion:

- Lived in U.S. for over half of their life
- Have at least a B.S. in any engineering discipline from an accredited university in the US

- Identity as Black and/or African American
- Work in the U.S. context beyond academia for at least 2 years
- Work on a project related to disasters (natural or man-made) in the past 5 years
- Display a tendency to identify and/or address social inequities (health, environmental, and/or infrastructure)
- Feel comfortable being questioned about their conscious experiences
- Have at least 4 hours to share their experiences with a researcher
- Informed consent

This sample is reasonable because I have at least two different gender representations, four different engineering disciplines, and a representation of engineers working to address three different types of social inequities (health, environmental and/or infrastructure). In the next section, I will discuss how I collected the data for each case.

3.5.2 Data Collection: Narrative Interview

Once I selected the cases, I scheduled narrative interviews through Calendly's scheduler (Calendly, n.d.). A few days before the interview, narrators were asked to reflect on their journey in addressing social inequities to have enough time to reflect on their SPD journey. The interview protocol was one single question to get the narrator to tell me about their journey. I followed the BNIM narrative inquiry method provided by Chamberlayne and Rustin (2002). The guiding question was, "Tell me about your journey to becoming an engineer who incorporates social justice in their practice and disaster management work." Follow-up questions were only about the settings, roles, and experiences mentioned in the interview. There was minimal direction or interruption while the narrators shared their career narratives; therefore, narrators had complete freedom in how they told their narratives.

While the narratives progressed, I had a checklist of events, space in time, and SPD elements to ensure the significant topics of this dissertation study was discussed during the interview (Fetterman, 1989). The important topics focused on the three levels of SPD: non-critical/denial, precritical blame, and critical consciousness. As narrators shared their stories, I checked off levels that had been covered and noted new topics raised in the narrators' stories that are worthy of follow-up questions. Each interview was scheduled for an hour and a half, but sometimes went a little longer if needed. In the next section, I will explain the first round of analysis for the foundational narrative interview.

3.5.3 Data Analysis: Narrative Construction

The foundational interview served as a framework for the narrative construction draft. Following the first interview, I listened, edited, and transcribed interviews through Otter (Otter.ai.,

n.d.) to construct each narrator's case narrative. These transcripts were analyzed to understand the structure of each story and how it relates to the levels of SPD. First, I understood the big picture of each narrator's narrative as a whole by asking ten high-level questions to capture the big picture and memo my responses. The questions are as follows:

- 1) Who are the main characters in this narrative?
- 2) What is happening in the narrative?
- 3) When are the events taking place?
- 4) Where are the events taking place?
- 5) Why are these events happening from the narrator's perspective?
- 6) How do these major events emerge?
- 7) Does this relate to *awareness*, *behavior*, or *consequence* domains?
- 8) What level and stage of SPD does this relate to?
- 9) What types of social inequities are being discussed?
- 10) What socio-ecosystem levels are they taking place on?

Through this process, I wrote notes in the margins of the data to capture in-vivo codes according to the questions posed. The first round of codes was ordered in Lucid chart (Lucidchart, n.d.) visualize and define critical structures within the career journey in chronological order.

Following, the narratives' components related to SPD domains (awareness, behavior, and consequence) were placed in swim lanes for non-critical, pre-critical, and critical in the same Lucid chart. The codebook I used for SPD domains and levels were the parent codes found in Table 4. In the middle of the career lane and SPD lanes, I identified which incident in the career lane contributed to the SPD component. An example of a narrator's draft SPD mapping is provided in Appendix C.

Table 4. *My Codebook for Identifying SPD Domains and Levels*

| SPD Element Parent Codes | Definition |
|---------------------------------|--|
| Domains | |
| Awareness | Noted when narrators mention an instance when they reflect or ignore the underlying causal factors or potential solutions surrounding an event along their journey to social justice; This is specifically noted apart from consequence when narrators mention a reflection or lack thereof from an event outside of themselves. (i.e. learned from a classroom, attending an event) |
| Behavior | Noted when narrators mention an instance when they are consciousness of potential actions to challenge inequities within environments surrounding an event along their journey to social justice; This is specifically noted when the narrator mentions actions that can do for themselves and outside of themselves to challenge inequities (i.e. self-empowerment, dialogue, create project) |
| Consequence | Noted when narrators mention an instance when they experience a temporal aspect that helps reveal cause-and-effect relationships between social forces and social circumstances and the believed effect of inequities surrounding an event along their journey to social justice; This is specifically noted if the narrators have this experience during the interview or if the narrator mentioned delayed reflection that had a greater impact later; Also noted when participants have an internal process that was not directly presented to the narrator (i.e. reading a book, research, witnessing wrong doing) |
| Levels | |
| Non-Critical | Noted when narrators mention an instance when they do not consider the individual and social forces that shape people’s lives or the identified problem surrounding an event along their journey to social justice; This is specifically noted as narrators breeze by uncomfortable events or mention that they ignore their emotions in order to get by (i.e. passive acceptance and suppressing emotions) |
| Precritical | Noted when narrators mention an instance when they blame individuals for the exclusions of all other systemic factors or social forces for problems and/or shape of people’s lives surrounding an event along their journey to social justice; This is specifically noted when narrators make excuses for events or direct their reflection on events beyond system issues (i.e. blaming people involved, blaming type of university) |
| Critical | Noted when narrators mention an instance when they take into consideration the individual and social forces that shape people’s lives of the identified problem surrounding an event along their journey to social justice; This is specifically noted when discuss oppressive forces that are beyond the people involved or people in environment (i.e. whiteness, capitalism, exclusion, social-technical dualism) |

The initial codes assigned to the incidents were as close as possible to the narrator's terms given the inductive approach to analysis from the Multiple Case Study method (Shkedi, 2005). This constructivist-narrative approach allows me to consider the narrator's cultural context in which they describe their sociopolitical development. I intentionally aligned terms in their immediate context. This stage ended for each narrator when I constructed their case narrative and mapped their SPD trajectories. To ensure trustworthiness, each draft of the SPD maps was saved so that I could revisit it if deemed necessary. For each incident, I identified gaps in the context of their career journey and SPD trajectories. These gaps informed follow-up questions asked during the second interview. In the next section, I will discuss the follow-up interview.

3.6 Phase 2: Narrative Refinement

Following Phase 1, the foundational interview is the first step in narrative refinement. The foundation interview data analysis outcome is the SPD plot's first draft. Furthermore, this draft serves as the foundation of the protocol for the follow-up interview. Once participant feedback is incorporated into the SPD, the outcome is the second draft of the SPD plot. Lastly, the analysis of the follow-up interview will serve as the refining element of the SPD plot used to construct the final narratives found in Chapter 4. The following section will go into detail for each component of narrative refining.

3.6.2 Data Collection: Follow-Up Narrative Interview

The follow-up interview served as a verification of the full narrative. The follow-up interview protocol was created after the narrative construction framework. This framework was presented to each participant for their feedback on identified gaps and clarification. The interview questions were related to the stages of SPD, awareness, behaviors, consequences, and critical incidents roughly following Flanagan's (1954) critical incident technique. The aim of the follow-up interview is to understand the context surrounding critical incidents that influence SDP to answer RQ2a and RQ3. This interview was scheduled for 1.5 hours and lasted longer, depending on the initial interview and the narrator's openness. The follow-up interview protocol is also included in Appendix D and demonstrates the collaborative nature of the follow-up interview. The collaborative interview created a second draft of the narrative framework. The next section will discuss the analysis of the follow-up interview.

3.6.3 Data Analysis: Transaction Analysis

Following the follow-up interview, I transcribed interviews through Otter and integrated critical incidents into the second draft of the narrative framework. These transcripts were analyzed to identify critical incidents embedded within the narrators' stories. Furthermore, I identified how the critical incidents influenced domains and levels conceptualized by transformative consciousness outlined by Jamal (2018). Table 5 depicts the codebook that was used to categorize and map the critical incidents, domains, and levels identified in the follow-up interview. The levels of SPD are separated into critical, pre-critical, and non-critical. Critical is the highest level of Jamal's (2018) Theory of Transformative Consciousness, considering the individual and social forces that shape people's lives or the identified problem. Pre-critical is the

second level that blames individual(s) for excluding all other systemic factors of social forces for problems. Lastly, the lowest level does not consider the individual and social forces that shape people's lives. This theoretical framework can be applied to various social issues, which is helpful for this study with multiple case narratives.

I paid close attention to the characteristics of the settings, individuals, and language from all the data sources instead of centering only on critical incidents. Specifically, as the narrators described their development, I jotted memos of the goals, decisions, and intentions prior to entering a setting and its interrelated outcomes on well-being, behavior, and cognition/emotions. A transactional approach to the research analysis captured the context, roles, and specific experiences that contribute to SPD. Altman and Rogoff (1987) define transactions as “holistic entities” composed of “aspects” rather than separate parts or elements. Given that social actions within an individual take place in the context of prior events and contain insight for future actions, the understanding of events in the narratives requires attention to the emergent process of development that is not separated from knowledge of the setting or characteristics of the participant. The transactional approach to data analysis enabled me to take an ecological lens on the interrelated nature of psychological and environmental features in the participants' narratives using the full codebook in Appendix E. A subset of this codebook is shown in Table 5 to demonstrate the ways SPD elements and incidents were situated in sociopolitical systems to answer RQ3. The outcome of the data analysis in phase 2 is the illustration of the ways memorable events align with the discourse on critical consciousness.

Table 5. *My Codebook for Identifying Sociopolitical Systems According to Their Socio-Ecosystem Levels*

| Socio-ecosystem Codes | Definition |
|------------------------------|--|
| Intrapersonal | Note when the narrator discuss internal processes that relate to the self; includes the process that exist only within a person (e.g., internal thoughts, attitudes, emotions and beliefs) |
| Mesosystem | Noted when narrators discuss interactions between different parts of a their microsystem (e.g. family, education and workforce) in which the microsystem exert influence upon each other |
| Exosystem | Noted when narrators discuss interactions between institutions/engineering education department in which the individual plays no role in decision making process but it has a direct or indirect impact on the individual level |
| Macrosystem | Noted when narrators discuss sociopolitical environment, culture, norms, values, laws, attitudes, and ideologies. This includes when they discuss known aspects of an environment that cannot be related to an individual interaction. |

3.7 Phase 3: Cross-Case Analysis

The primary component of the cross-case analysis was a thematic analysis of the SPD plots, which centered on the SPD components and critical incidents within socio-ecosystem levels. As a reminder, the SPD plots were a result of the within-case narrative report. The cross-case analysis provides the answers to each research question. To answer RQ1, I conducted a within-case analysis by utilizing the identified critical incidents, SPD levels, domains, and socio-ecosystem levels to support the within case-narrative report. To answer RQ2 and RQ3, I conducted a cross-case analysis across each case-narrative report to identify cross-case categories and trends.

I decided to utilize the ‘category-oriented ordering’ method of organization in analyzing the narrative since the cases were similar with slight variations in differences, and there is a need to maintain the anonymity of the narrators given their professional positions (Huberman & Miles, 1994). Utilizing this method, I incorporated all data (case narratives) into one Excel sheet to indicate the domains, levels, and socio-ecosystem levels according to each scene from which the SPD element belonged. This ordering helped me get a complete picture of the cases without paying particular attention to the differences and uniqueness of each case narrative. In addition, this helped me order the data belonging to the same category according to prevalence dimensions.

In answering RQ2, I focused specifically on the SPD levels and domains and identified trends within each category (RQ2a). Following, I graphed each individual’s SPD levels throughout their narratives and identified patterns in their movement (RQb). Lastly, RQ3 situated the critical incidents that resulted in SPD elements within socio-political systems. The outcomes RQ1 is a within-case narrative report while RQ2 and RQ3 provide an in-depth description of SPD development of five Black engineers across case narratives. Methods for each question will be discussed in greater detail in the following section.

3.7.1 Methods for RQ1: What events depict the trajectory of Black engineers’ sociopolitical development (i.e., career narratives) focused on disaster management?

To answer RQ1, I presented a within-case narrative report utilizing the outputs from phases 1 and 2. Through narrative construction and refinement, I utilized SPD plots to bring in narrators’ full text to supplement the core details surrounding their career journeys. For readability, I divided the narratives into scenes to identify the role of critical incidents in SPD.

Critical incidents were considered memorable career events that influenced the narrators' critical consciousness. Critical consciousness refers to an individual's awareness of oppressive system forces and a sense of efficacy and engagement in action against oppression. Under each scene, I provided a summary of the events discussed and their influence on SPD. Then centering on the narrator's own words, I bracketed what I considered as SPD elements noting the SPD level and domain. For example, I would note the SPD level and domain with the participants' quotes [Pre-Critical Awareness]. Furthermore, each case narrative consisted of a guide identifying the scene number, point in the timeline, critical incident, SPD level, SPD domain, and sociological ecosystem. In the next section, I will analyze the SPD elements across cases to answer RQ2.

3.7.2 Methods for RQ2: How do SPD elements manifest in the career narratives?

To answer RQ2, I asked and answered two sub-questions: (RQ2a) How do SPD domains and levels show up in the career narratives? (RQ2b) How do they move through the SPD elements throughout their careers? Together these questions provided an in-depth description of how SPD elements manifest in career narratives. I will describe the methods employed to answer each question.

3.7.2.1 Methods for RQ2a: How do SPD domains and levels show up in the career narratives?

To answer RQ2a, I categorized the narrator's description of SPD into the operationalized definitions of Transformative consciousness. I downloaded narrators' descriptions into an Excel sheet and created columns for *awareness*, *behavior-response*, and *consequences*. First, I ensured that each participant's quote aligned with the SPD domain category identified in Figure 1. At this

step, I noticed that *awareness* and *consequence* domains were similar and made a distinction between passive acceptance (i.e., learning a new concept from a teacher/peer, watching a documentary, reading a book) and internal processing (i.e., noticing something happened, reflection on it, and drawing a conclusion). Then, I started to group the narrator's instances around common elements within each domain. Lastly, I shared the grouping with other researchers to ensure the grouping and naming were validated. I repeated this step for each domain and ensured there were not any repeats. After categorizing domains, I repeated the same steps for the SPD levels and created a separate Excel sheet with the columns *non-critical*, *pre-critical*, and *critical*. Therefore, the same quotes were categorized into domains and levels without any repeats.

Table 5. *Levels and Domains of Transformative Consciousness (Adapted from Jemal, 2018)*

| | Domains | | |
|--------------|--|---|--|
| Levels | Awareness | Behavioral response | Consequence |
| Non-critical | The lack of critical thought and insight about individual and social forces that underlie the identified problem and/or shape people's lives | The lack of consideration of reaction(s) (action or verbal) that responds to the individual and social forces that shape people's lives or the identified problem | The lack of consequence of present or potential events and their outcomes that takes into consideration individual and social forces that shape people's lives or the identified problem |

| | | | |
|---|---|--|---|
| <p>Precritical</p> | <p>An understanding of causal factors that blame individuals to the exclusion of all other systemic factors or social forces of identified problems that shape people’s lives</p> | <p>The consideration of a response (action or verbal) aimed at the perceived blameworthy individual(s) to the exclusion of all other systemic factors or social forces of identified problems that shape of people’s lives</p> | <p>The consequence of present or potential events and their outcomes that blame individual(s) to the exclusion of all other systemic factors or social forces of identified problems that shape of people’s lives</p> |
| <p>Critical</p> | <p>The consideration of thought(s) and insight about individual and social forces that shape people’s lives or the identified problem</p> | <p>The consideration of reaction(s) (action or verbal) that responds to the individual and social forces that shape people’s lives or the identified problem.</p> | <p>The consequence of present or potential events and their outcomes that takes into consideration individual and social forces that shape people’s lives or the identified problem</p> |
| <p><i>Note.</i> Items were categorized in the behavior-response domain if they reference choices they individually made or verbs surrounding their engagement in activities around them. Furthermore, a distinction was made between <i>awareness</i> and <i>consequence</i> by identifying the passive acceptance surrounding awareness and active engagement surrounding consequence.</p> | | | |

3.7.2.2 Methods for RQ2b: How do they move through the SPD elements throughout their careers?

The third phase of this research process centers on cross-case analysis. To answer RQ2b, I presented cross-case trends in the narrators’ movement through SPD elements utilizing timeline and SPD levels identified in the within-case narrative report. This graph illustrates movement

through SPD according to each critical incident (identified as numbers in scenes). The x-axis presented a timeline (left to right) separated into childhood, K-12, undergraduate, graduate, and workforce to depict the chronological order of the full narratives. Whereas the y-axis presented SPD levels (bottom to top) separated into non-critical, pre-critical, and critical. The finalized graphs of the case narratives' SPD levels were then grouped and categorized according to the individual's relationship with the SPD levels.

3.7.3 Methods for RQ3: What sociopolitical systems shape the SPD?

To answer RQ3, I revisited the critical incidents and subsequent quotes related to SPD level and domains in RQ1 and RQ2a to situate these incidents into sociopolitical ecosystems. Similar to RQ2a, I downloaded the narrators' descriptions into an Excel sheet and created columns for *intrapersonal*, *interpersonal*, *microsystem*, *mesosystem*, *exosystem*, *macrosystem*, and *chronosystem*. First, I ensured each participant's quote aligned with the socio-ecosystem level categories in Table 3. Then, I started to group the narrator's instances into groups around common elements within each socio-ecosystem level. Lastly, I shared the grouping with other researchers to validate the grouping and naming. Since there were multiple SPD elements associated with critical incidents, depending on the nature of the SPD elements there were a few critical incidents identified as being situated in multiple socio-ecosystem levels. However, no repeats of SPD narrator quotes were categorized in multiple socio-ecosystem levels. In conclusion, I was able to provide an in-depth analysis of various socio-political systems across case narratives. The following section will discuss the quality considerations and decisions to ensure the reliability and validity of this cross-case analysis.

3.8 Research Quality

Within this research design, I considered a quality framework that would complement the exploratory nature and narrative foundation of this design. Tracy's (2010) eight quality considerations pertaining to research provided the freedom of utilizing a relatively new conceptual framework that can assess the rigor and trustworthiness of the dissertation study while ensuring the highest priority of making a positive impact on the Black narratives under analysis. These considerations include a worthy topic, rich rigor, sincerity, credibility, resonance, significant contributions, ethics, and meaningful coherence. This section will highlight the critical decisions in this research design that account for the eight research quality considerations.

Within Tracy's (2010) article, a worthy topic in research can be achieved by considering how relevant, timely, significant, and engaging the subject is. Critical consciousness is under debate given recent education policies in the US that seek to remove students' understanding of historical oppression; therefore, this is a very relevant, timely, significant, and engaging subject in engineering education. In addition, disasters are at the intersection of these four criteria because disasters impact everyone in society and are predicted to worsen in the future. Furthermore, according to the United Nations Office for Disaster Risk Reduction (UNDRR) (2015), the entire world is getting close to what can be considered the absolute highest levels of inequality. Disaster risk is shaped by various social and economic factors determining who can be resilient. Critical factors in underserved areas include low-quality and insecure housing, which limits access to essential services such as health care, public transport, communications, and infrastructures such as water, sanitation, drainage, and roads. Engineers directly impact these systems, and disasters are significant and exciting contexts to explore how SPD emerges through

engineers' professional training. Within exploring the topic of SPD in Black engineers' preparation, I have heavily considered rich rigor in the research design. I used Jemal's (2018) Theory of Transformative Consciousness surrounding SPD levels, domains, and sociopolitical systems to analyze data and bound cases by the narrator's narratives. Within the theoretical framework, I excluded the SPD stages analysis to reduce complexity. The diversity in the sample emphasizes that Black people are not monolithic.

The data collection and analysis processes are described in detail throughout this chapter. Furthermore, I have multiple data sources that are triangulated in the data collection process and an analysis process with multiple layers that are documented throughout every reiteration process. Furthermore, I have considered sincerity by clarifying my intentions through self-reflexivity and transparency. The essential measures of quality in the multiple-case narrative methodology are trustworthiness (Shkedi, 2005). Trustworthiness is achieved through validity, reliability, and generalization. In narrative research, data validation was achieved by constant reflection and verification in the data analysis process. The purpose of the follow-up narrative interview was for validation purposes. I moved back and forth between induction and deduction, experience and reflection on experience, data, conceptual perspective, and personal perspective and results. The data analysis between interviews ensures that data is captured solely from the narrators' own words and mapped to the SPD synthesized framework.

On the other hand, reliability requires that I am transparent with the research process and decisions, and consistently use the same processes and decisions to guide data collection within each case. I kept a researcher memo to ensure reliability and develop an in-depth description of the data provided and how it is further analyzed. In addition, I bracketed my personal experiences and ensured that the data reflected practitioners' narratives by dedicating significant

space to my positionality described in section 3.2. Furthermore, credibility was established in Phase 2 with a follow-up interview that integrated member reflections on SPD plot trajectories. The extent to which this research resonates with the broader engineering field is also heavily considered.

Within Chapter 7, I discuss how the findings are transferable to present literature surrounding Black experiences in engineering. Since the cases are similar in an engineering discipline and academic environments, I can transfer findings to spaces centered on civil engineers and PWIs. As I consider resonance, I must provide a rich, detailed, thick description of the SPD process. Generalizing the findings that emerged from using the multiple-case narrative method is accomplished through case-to-case abstraction, analytic generalization, and generalization from sample to population. As a result, I can make analytical generalizations to expand the theory of SPD. The findings of this study are strengthened through the validity of the methods employed and provide a significant contribution to SPD theory and engineering practice. SPD has made considerable contributions to youth development, and this dissertation study expands SPD to professional development.

I ensured this dissertation went under IRB review and implemented caution with my participants' identity and any communities they advocate for by removing any identifying information. For this reason, each research narrator selected a pseudonym and was about to withdraw information from the study at any point. Most importantly, I provided spaces for Black narrators to share their innermost thoughts without judgment and expressed gratitude for their meaningful contributions to research on SPD.

3.9 Summary

In summary, this research design consisted of three phases that were validated and in alignment with my research positionality. Figure 8 depicts the essential research outcomes from each phase. Given the methodological choice of a Multiple-Case Narrative methodology, I incorporated elements of both narrative and multiple-case study. Narrative construction (phase 1) and narrative refinement (phase 2) centered on narrative methodology whereas the cross-case analysis (phase 3) centered on multiple-case study methodology.

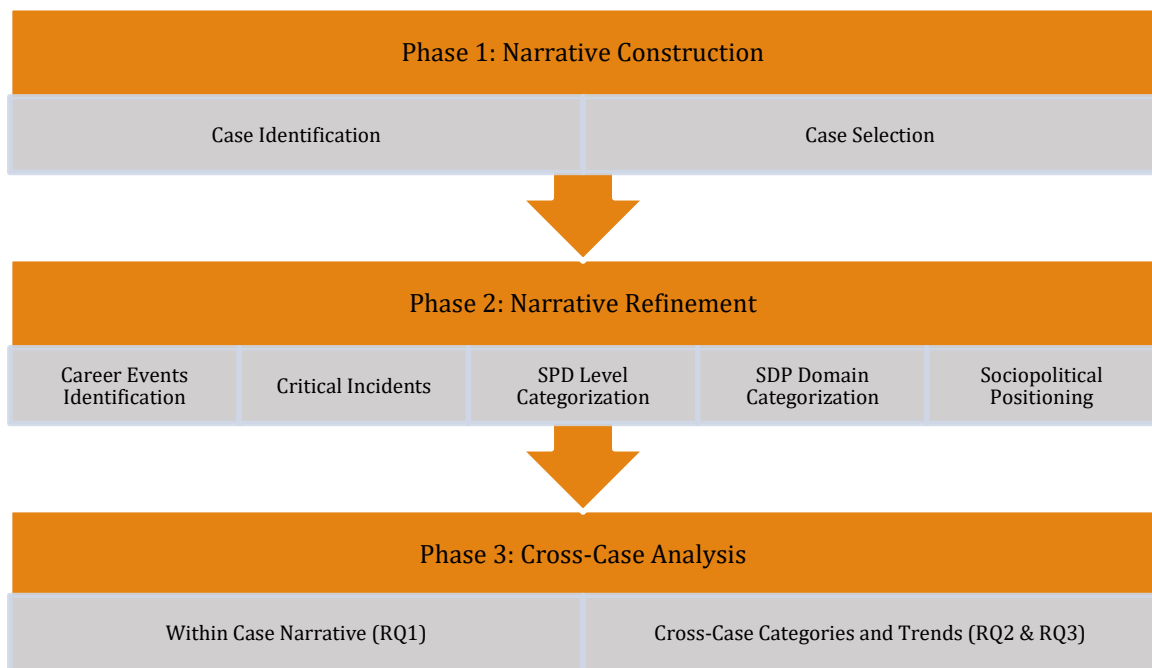


Figure 3. *Significant Research Outcomes*

The outcomes of narrative construction were identified as valuable cases for the purpose of this study, and selected the cases to move forward within phase 2. Once cases were described and selected, I focused on narrative refinement which resulted in a reiterative process of collaborating with narrators and revisiting the theoretical foundation to identify career events,

critical incidents, SPD levels, domains, and socio-political systems at play. Lastly, the outcome of Phase 3 was a complete narrative with multiple illustrations in the narrator's SPD processing, which were then analyzed in trends with categories across domains, levels, movement and socio-ecosystem levels. In conclusion, this research design was employed to answer the overarching research question: *How does the SPD process unfold through the career narratives of five Black engineers?* The detailed narratives are provided in Chapter 4 to present the collection of narratives that capture the real experiences and the surrounding context of five Black engineers' SPD. Then, Chapters 5 and 6 present the cross-case categories and themes analyzed to present an in-depth description of five Black engineers' SPD process and its relation to engineering practice.

4. Chapter 4: Collection of Narratives (RQ1)

4.1 Introduction

This chapter will answer RQ1, which states: *What events depict the trajectory of Black engineers' sociopolitical development (i.e., career narratives) focused on disaster management?* In this chapter, I will present the narratives of each narrator: Khalil, Nina, Penguin, Richard, and Vee. A summary of each narrator is provided in Table 6. I initiated these narratives by asking the narrator to describe their career pathways of incorporating social justice into engineering work. However, within these conversations, we (i.e., the participants and I) discussed motivations, heartaches, isolation, community, challenges, and triumphs. It is essential that I retain the essence of the memories shared and prioritize the narrator's voice as I present each case. Therefore, when presenting the narratives, I rely heavily on a narrative structure centered around the first person's point of view, polished only to highlight the critical incidents that influence sociopolitical development (Kellam, Gerow & Walther, 2015).

Table 6. Summary of Individual Cases in Sample

| Pseudonym | Khalil | Nina | Penguin | Richard | Vee |
|--|--|---|--|--|---|
| Trained Engineering Disciplines | B.S. in Civil Engineering; MS in Environmental Engineering; Ph.D. in Environmental Engineering | B.S. in Civil Engineering; MS in Industrial and Systems Engineering | B.S. in Civil Engineering; MS in Civil and Environmental Engineering | B.S. in Civil Engineering; MS in Transportation Engineering; Ph.D. in Transportation Engineering | B.S. in Civil Engineering; M. Eng in Environmental/Environmental Health Engineering |

| | | | | | |
|---------------------------------------|--|---|--------------------------|---|---|
| U.S. Region of Training | Southwest | Midwest | West | Northeast | Southeast and Northeast |
| Self-Identified Gender | Man | Woman | Woman | Man | Woman |
| Self-Identified Race/Ethnicity | Black and Southeast Asian | Black and Afro-Caribbean | Black | Black and Afro-Caribbean | Black |
| Current Titles | Environmental Justice Engineer, Consultant & Community Scientist | Strategic Project Manager, Entrepreneur & Lifecycle Manager | Associate Civil Engineer | Transportation Planning Project Manager | Environmental Engineer & Environmental Justice Policy Advisor |
| Social Inequities Addressed | Health | Infrastructure | Environmental | Infrastructure | Environmental |

Each narrative was co-constructed by the narrator through meaningful dialogue to include their personal experiences, context, memories, and the process of sharing their stories with me. There were many career events discussed in the interviews, which are defined as memorable events that took place alongside their engineering career journey. However, the narratives presented in this chapter will center on critical incidents, which, in the context of this study, refer to memorable incidents that influence critical consciousness. As a reminder, critical consciousness refers to an individual's awareness of oppressive system forces and a sense of efficacy and engagement in action against oppression. The storytelling format of this section pays homage to Black culture; as a Black researcher, it is essential that I pay the highest respect to the memories each narrator entrusted me to carry.

There is a particular historical perspective on narratives in the Black community. In 1994, Lawrence-Lightfoot described narratives or storytelling as a tradition that continues from Africa, where stories are filled with adventure, entertainment, cultural knowledge, and history. The narrators in this dissertation study utilized the same medium, storytelling, to share the development of their awareness, behavior, and consequences in relation to their placement in engineered systems of oppression and their role within them. The journey of each engineer is a multilayered and unique experience in the discovery of self and the world around them.

In this chapter, each narrative is broken up into scenes that signify essential elements surrounding critical incidents in their critical consciousness development. At the beginning of each narrative there is a scene guide that identifies scene number, critical incident, SPD levels, SPD domains and related sociopolitical system. Furthermore, at the beginning of each scene, there is a summary. Identified SPD elements can include thoughts, feelings and perceptions surrounding a core memory along its sociopolitical development. The identified SDP domains and levels are identified using brackets and appear in the following format: [Critical Awareness]. These brackets are situated within each scene. In this chapter, the narratives are referred to as voyages and I will present each narrative in the following order: Khalil, Richard, Nina, Penguin and Vee.

4.2. Voyage 1: Khalil

Khalil identifies as an environmental justice engineer and community scientist in the professional realm. He is a bi-racial (both Black/African American and Southeast Asian) man located in the southeast region of the United States. His primary engineering degree is in Civil Engineering, and his highest level of formal schooling is a doctorate. Currently, his professional engineering work is situated in public service where he works closely with

community advocacy groups, which is the primary reason he was selected to participate in this study.

In starting the narrative, Khalil made it clear that he was not an engineer that incorporated social justice. In his practice, he believed he was a social justice advocate who got educated and trained in an engineering discipline. He noted that there are advocates from all disciplines and all backgrounds of formal and informal training, education, and practice. In the context of this narrative, he equipped himself with engineering design tools in scientific research. Of the narrators in this study, he was the only one to note that he was a social justice advocate before he knew what engineering was. From this perspective, he is a social justice advocate who incorporated engineering as a tool for his advocacy.

Table 7. Khalil's Scene Guide

| Scene # | Timeline | Critical Incident | Sociopolitical Level | Sociopolitical Domain | Sociological Ecosystem |
|----------------|-----------------|---|-----------------------------|------------------------------|-------------------------------|
| 1 | Childhood | High critical conscious household/ family | Critical | Awareness | Mesosystem |
| 2 | K-12 | Experienced discrimination for being Black | Pre-critical | Consequence | Interpersonal |
| 3 | K-12 | Changed schools to be in a more diverse environment | Pre-critical | Consequence | Mesosystem |
| 4 | K-12 | Black identity development | Critical | Behavior | Interpersonal |
| 5 | K-12 | Decided to pursue an engineering career | Critical | Awareness, Consequence | Intrapersonal |
| 6 | Undergraduate | Enroll in a predominantly white institution (PWI) | Critical | Consequence | Mesosystem |

| | | | | | |
|---|-----------------|---|----------|----------------------------------|---------------|
| 7 | Undergraduate | Participated in both domestic and international community projects throughout entire college career | Critical | Awareness, Consequence, Behavior | Interpersonal |
| 8 | Graduate School | Developed the skill of research and applied it in various contexts | Critical | Awareness, Consequence | Chronosystem |
| 9 | Workforce | Received incentives for making the desired impact | Critical | Behavior, Awareness | Chronosystem |

4.2.1 Scene K1: Family Influence on Critical Awareness

Space in Time-Childhood

Summary: Khalil's scene K1 describes the critical consciousness level of Khalil's parents and how this influenced the way he was aware of systems of oppression through his parents teaching.

My journey begins with an understanding of my family history. My parents grew up in very different contexts geographically, one was southern domestic, and the other was an immigrant. While there were many differences, there were also many similarities in shared pain, struggle, oppression, social, legal, political, economic, and environmental injustice, and more. This understanding shaped the individuals that they grew and came to be. The awareness of social oppression became a common life experience among them. This understanding shaped how they viewed and navigated the world as a partnership.

[Critical Awareness] *The experiences that influenced my parent's perspective exposed me to systems of oppression and were also integrated into the framework in which they raised me. In*

addition, I have also had my personal experience with different injustices being exposed either directly or indirectly through experiences that my friends and family have had. For example, my parents and I lived in affordable housing, and I reflect on this as I engage with communities of low income.

Beyond friends and family, I have been exposed to injustices through the consumption of media portraying people that are similar to me. However, my journey starts by being raised by individuals who are hyper-aware of injustices.

4.2.2 Scene K2: Childhood Experiences Influence on Pre-Critical Consequence

Space in Time-K-12

Summary: Khalil's scene K2 describes a K-12 fight where Khalil was being bullied for being Black and he needed to defend himself. As he evaluated this scenario, he discussed how the environment was the reason for this discrimination and how he changed schools to lower his potential experience with over discrimination.

Even starting from a young age our parents presented me with an age-appropriate analysis of how I was experiencing the world. Whether it's through a conflict I have in grade school or something as simple as going to the grocery store, when I was outside in the world with them and observing something happening, they would present me with an analysis of social oppression on events I am either observing or experiencing. They would affirm me and say "yes, you're definitely seeing what you're saying" and provide the context of these experiences in the US. They always provided the space for reflection and discussion on why things happened and how they are integral to all aspects of life.

For example, when I was in early grade school, I went to a school that was almost entirely white, and my friends were white. I got picked on one time for being Black, and I was

raised to stand up for myself and to stand up for others. I consider myself defensive so it's natural for me to stand up and defend myself and others due to my upbringing. In this situation, I was being disrespected as a direct result of just being a little Black boy, and as a response, I chose to stand up for myself by clapping back and roasting the people who were picking at me. One kid got very upset and started to get physical with me. I fought back and got in trouble with the school. As a result, I was called down to the principal's office and explained the situation to my parents. Since they told me always to defend myself, my parents were very proud. This event wasn't the catalyst, but it confirmed to my parents that I should probably be in a school with people that look more like me and reflect my socio-economic background.

At this age, I've already demonstrated at a young age that I'm not going to lie down since my parents raised me not to. Throughout my childhood and grade school experiences, I have always received reinforcement from my parents that emphasized that standing up for myself is the expectation.

[Pre-Critical Consequence] We faced two options: either constantly being placed in conflict with this predominantly white environment or feeling support in an environment more representative of not just myself in my background, but the society in which I live. We decided to change schools and be in a diverse environment.

4.2.3 Scene K3: Diverse Environment Influence on Pre-Critical Consequence

Space in Time- K-12

Summary: Khalil's scene K3 depicts the positive impact of being surrounded by a racial and cultural community closer to one's identity in a new educational environment.

[Pre-Critical Consequence] Once I changed schools, I remember feeling like I belonged to a racial and cultural community that I had not experienced. Before changing schools, the

school environment did not feel like my social learning environment. However, after changing schools, more people shared my racial and cultural identities. Then, the school environment for me became an affirming space. I felt more comfortable being myself as opposed to feeling like I always had to fight by myself. These early experiences affirmed my value for the community.

Don't get me wrong, stuff will still pop off, but I had community and didn't have to go through it alone. We would still come out swinging and it was nice to have a community that helped me feel like I'm not crazy for feeling a certain way. This showed up in something as simple as sitting with Black kids at lunch. It's not like people weren't friends with other people but I found it comforting in a way that I had not experienced before.

4.2.4 Scene K4: The Influence of Black Identity Development on Critical Behavior

Space in Time- K-12

Summary: Khalil's scene K4 describes the comfort Khalil experienced as he was exposed to his racial identity and was able to participate in his Blackness.

[Critical Behavior] *As I felt more comfortable being myself, I start growing my hair out and having different styles like cornrows. I found myself practicing aspects of culture that I haven't before including entertainment or sports or social interactions. Many of these experiences can be attributed to general exposure during my teen years; however, I remember the teen experience being paired with exposure to my racial and cultural groups. In summary, I started feeling more Black and more comfortable being Black. Not only confidence in being Black, but joy and pride in being Black, as opposed to earlier in life, when my home environment was very good for affirming environment, but my first schooling environment was not. I began not to be defensive about my Blackness and more accepting of who I am and have always been.*

At this age in my life, I am continuously becoming more comfortable, more affirmed, more proud, more open, and more willing to express racial and cultural aspects of myself openly.

4.2.5 Scene K5: The Influence of Pursuing an Engineering Career on Critical Awareness and Consequence

Space in Time- K-12

Summary: Khalil's scene 5 discusses his decision to major in engineering and noticing the centrality of whiteness. However, he pursued engineering because of his love for math and science and cut off his hair to prepare to go to PWI.

I decided to be an engineer right before I applied to college because that's when I learned what engineering was.

[Critical Awareness] *When reading children's books, I always noticed that whether you saw a doctor, lawyer, or engineer, it was always a glorious white man.*

The engineer was always in a conductor hat hanging out the back of a caboose on the train. Therefore, when my teacher suggested that I be an engineer, I told her I didn't like trains like that. Then, she explained that there were different types of engineers and that it related to math and science, which I loved. However, I had no idea what engineering was at the time. Civil and environmental are the only disciplines that made sense because it's the only thing that I could see. For example, I've seen a bridge and a building and knew they were essential infrastructure. Since my parents grew up rough, safe and affordable housing was not always guaranteed. I figured that if I can learn engineering design, then I can help build safe, affordable housing for people.

[Critical Consequence] *Therefore, I never considered myself someone who incorporated social justice into engineering. Before I enrolled in engineering I knew colonization, capitalism,*

and racial discrimination existed. Knowing that these systems existed, I cut my hair; not because I wanted to cut it, but because I felt like I had to cut it. I knew I was going to this PWI, and I was trying to secure internships. I cut it by simply trying to assimilate in ways I didn't want to, but I felt like I had to.

4.2.6 Scene K6: The Influence of PWI on Critical Consequence

Space in Time- Undergraduate

Summary: In scene K6, Khalil describes his challenges navigating engineering that include academic and job opportunities. However, he describes NSBE as a place of support while also evaluating the limitations of academia as he desired to engage in action.

That first year of college I struggled and almost got weeded out my first semester. I did well in high school and excelled in everything else in my life so far academically so I thought this would carry me. However, I was mistaken when I failed my first chemistry course. It felt like I was having an identity crisis.

For instance, even after assimilating, my homies and I had 3.9 GPA plus and attended various career fairs trying to get jobs and internships. We couldn't get one interview, whereas these white boys had 2.7 and gained two or three offers. I tried to assimilate as much as possible by literally cutting pieces of myself to be accepted by these institutions and systems and still not being good enough. At a PWI, things like this are being reinforced.

NSBE (National Society of Black Engineers) saved me from drowning in my first semester. They helped me study and provided me with community, some of whom are my best friends in life right now. For me personally, NSBE members became my family and home base. They emphasized leadership opportunities and it all started with academic excellence. I attribute NSBE as the reason I could stay in my program because we struggled together.

[Critical Consequence] *I went through my degree program with the motivation to engage in action. However, as I engaged, I started to learn more about the limitations and constraints, and false solutions that academia holds even in those types of spaces that claim to address social inequities.*

4.2.7 Scene K7: The Influence of Community Engagement on Critical Awareness, Consequence, and Behavior

Space in Time- Undergraduate

Summary: In scene K7, Khalil describes his involvement in community engagement and how it impacted his learning around social context, boundaries of engineering work and sense of agency in doing engineering work.

Throughout the entirety of my undergraduate experience, I have also been involved in multiple international and domestic sustainable development efforts.

[Critical Awareness] *Alongside the traditional engineering curriculum, I learned more about cultural, racial, economic, and geopolitical contexts.*

[Critical Consequence] *The more I got involved, I started to recognize patterns of engineers overstepping their boundaries. From this experience, I learned that everything cannot be solved with an engineering solution, nor should it be prioritized when creating a solution.*

[Critical Behavior] *I worked on humbling myself when I realized a particular situation need is more than the skills I had to provide. When a community has a greater pressing need then civil engineering should be an afterthought.*

4.2.8 Scene K8: The Influence of Grad School on Critical Awareness and Consequence

Space in Time- Graduate School

Summary: In scene K8, Khalil discusses his growth in awareness of underlying issues in sanitation and how this motivated his desire to go to graduate school. In graduate school, he was able to situate engineering work in social justice and gained the skills of research. However, through this experience, he also became more critical of higher education as he challenged assumptions and found himself in the perpetual conflict which trying to integrate social elements in a technical space.

Throughout my undergrad program, I had a certain level of understanding of the core root issues in engineering and the type of engineering that I went into. However, over time, I realized that I had pre-existing assumptions.

[Critical Awareness] *As I became aware of much larger issues like sanitation and sustainable housing, I noticed the underlying factors that have a greater impact on the quality of life. At the time I didn't have the skills to understand these factors in greater detail, so I went to graduate school to learn a skill.*

For my dissertation, I choose to look at how we can make engineering more aligned with advancing social justice issues such as social, racial, economic injustice, and inequity issues. I obviously had a lot of technical components situated within the context of these larger issues. It's important for me to make note that technical challenges don't exist in isolation; They exist within the context of society, which is full of inequities.

Learning the skills of research, and not just applying it to a particular topic, but applying it to processes and systems is the greatest thing I learned from grad school. The entire Ph.D. process was being able to identify assumptions and test those assumptions. These are skills I can apply to any field, and I've been applying this to many things.

[Critical Consequence] *I became more critical of higher education as I engaged with different projects and had the audacity to challenge things that I thought were wrong. When engaging with communities, I would find myself in conflict with team members when I speak up about communities having different perspectives, biases, blind spots, or anything that didn't align with the communities we were working with. Through these conflicts, I noticed patterns and commonalities that were differences in awareness, prioritization of different parameters, and differences in what success is determined to be. For instance, I would define success as equitable solutions that benefit social society with respect to marginalized groups, whether big or small. Whereas often times the groups I was working with defined success as scalable, profitable, and number of publications.*

4.2.9 Scene K9: The Influence of Community-Based Workforce on Critical Behavior and Awareness

Space in Time- Workforce

Summary: In scene K9, Khalil describes the fulfillment he now feels since he can engage with communities in his professional role. He became aware that his prior experience of isolation was due to the values within the environment.

After graduate school, I found myself in a space now where I can prioritize the work that I want in the way that I want. I have the skillset now due to all the experiences I mentioned along my journey.

[Critical Behavior] *Therefore, in my new workspace, I am more engaged with community-based organizations and coalitions and serve more in a service role versus a research role. I found more fulfillment by being engaged with communities, organizations, and coalitions. It was hard to have the level of engagement that I wanted through the group-seeking*

programs. Whereas, now that it is part of my actual job and I'm being paid to do it, it is both more fulfilling for me and essential to being successful in the work that I do.

[Critical Awareness] Before this space, I was given consequences for doing this work that I love to do. I felt like a lone wolf fighting to try to get people to understand. For instance, I've been told not to do it since the time and energy spent doing this work takes away from things I'm rewarded for. To me, this means that I wasn't working within an incentive structure that prioritizes community-based work, whereas now, I'm in an environment where I work closely in agreeance with what success looks like.

4.3 Voyage 2: Nina

Professionally, Nina identifies as a strategic project manager and entrepreneur. She is a Black woman located in the western region of the United States. Her primary engineering degree is in Civil Engineering and following received a bachelor's degree in psychology. Her highest level of formal school is a master's in industrial engineering. Nina was primarily selected for this study because her engineering work is related to disaster management and risk analysis. Currently, her engineering work is situated in entrepreneurship.

As you read Nina's narrative, understand that her major motivation was to achieve a higher lifestyle than her circumstances at the time. Compared to the other narratives presented in this section, social inequities were not central to her work because she was constantly in survival mode. She stated, "I did not want to live in the hood anymore and I wanted that suburban life I was seeing on TV, it just seemed like kind of chill and relaxing. So that's what I was like shooting for and striving for." Nina's story shows that Black engineers are not monolithic and provides a wide spectrum of sociopolitical development among Black engineers' career journeys.

Table 8. Nina's Scene Guide

| Scene # | Timeline | Critical Incident | Sociopolitical Level | Sociopolitical Domain | Sociological Ecosystem |
|---------|---------------------------|---|--|----------------------------------|------------------------|
| 1 | Childhood | Experience lack of STEM exposure and took a career assessment | Non-Critical | Consequence | Mesosystem |
| 2 | K-12 | Attend inner-city school | Pre-Critical | Consequence | Macrosystem |
| 3 | Undergraduate | Enrolled in PWI | Pre-critical | Consequence, Behavior | Macrosystem |
| 4 | Undergraduate | Grad school funding challenges | Pre-Critical, Non-Critical, Pre-Critical | Awareness, Behavior, Consequence | Exosystem |
| 5 | Grad School and Workforce | Enroll in psychology | Non-Critical | Behavior | Macrosystem |
| 6 | Grad School | Enroll in industrial engineering program | Critical, Pre-Critical | Consequence | Mesosystem |
| 7 | Workforce | Experience supervisor investment for the first time | Pre-Critical | Consequence | Interpersonal |

4.3.1 Scene N1: The Influence of Career Assessment on Non-Critical Consequence

Space in Time- Childhood

Summary: In scene N1, Nina describes herself as not having many role models and needing to turn to a career assessment test to determine her career path. As a result, she identified engineering as a potential path and lacked consideration of the impact she wanted to make or the social forces surrounding career decisions.

At the age of 10, I had no idea what I wanted to be. My dad was a computer engineer, and my mom was a nurse. Although my dad was a computer engineer, I had limited exposure

because my dad and mom split when I was six. I knew I didn't have any interest in their career choices, so my mom suggested that I take a career assessment. They asked questions about my interest, skills, and strengths, and it eventually provides me with three career path options: engineering management, actuarial science, and civil engineering. I researched civil engineering, and it discussed broad things that deal with just about everything such as building structures and transportation. I related this description to the game SimCity and found excitement in living the game in real life.

[Non-Critical Consequence] I didn't consider the impact that I wanted to make in engineering, nor did I even think I was oppressed at this point. I noticed the salary associated with engineering careers and accepted that this was what the universe is giving me. From there, I began my love affair with civil engineering and decided to say this was my path until I figure out what I want to do.

4.3.2 Scene N2: The Influence of Inner-City Schools on Pre-Critical Consequence

Space in Time- K-12

Summary: In scene N2, Nina refers to the students she went to high school with as underperformers and despised being grouped with them. She never told them that she was interested in engineering because she believed they didn't have the resources to support her.

Fast forward to senior year, we moved to a new city, and I had just gotten my acceptance letter into the civil engineering program. At that point, all I needed to do was graduate since I'd gotten all the credits I needed, dual enrolled at a nearby community college, and worked a part-time job.

[Pre-Critical Consequence] The high school I attended was an inner-city high school that was underperforming. It was the opposite of a creme de la creme and more so a place where you

get your degree in a graduating class of 100. Maybe out of that 100, two people will graduate with a bachelor's and the majority of them had kids within the first two years and did not make it past that hurdle.

Oftentimes, I found myself lumped into this group of students that were underachieving and needed an extra push. For example, we were all required to have three letters of acceptance to college and take the ASVAB. I already had a full ride to college and was never interested in going into the military, but I was never exempt from recruitment to the military. Therefore, I never told the guidance counselors or teachers that I was interested in engineering because I felt like they could not help me. I just focused on making it out and attending a university that was close to home.

4.3.3 Scene N3: The Influence of PWI on Pre-Critical Consequence and Behavior

Space in Time- Undergraduate

Summary: In scene N3, Nina describes herself being immersed in a segregated environment but listed the benefits of finding community. She evaluated the high dropout rate for racially minoritized individuals and insinuated that they would be successful if they utilized their resources. She went on to describe the segregation of resources and her need to network so that she can access to resources.

In my first semester, there was a minority engineering orientation where we discuss topics surrounding the department of engineering, the history of the school, job preparations, and tips on being successful in the engineering program. They separated us out, and they basically said, "all the white kids over here" and "all the Hispanic and Black students over here". It was so visibly noticeable in the room and was a little racist, but good at the same time

because then you got to see people who look like you going through this program. I'm still friends with quite a few of them, and it started off in that orientation.

[Pre-Critical Consequence] In the orientation, they had us count by five throughout this entire lecture hall of approximately 65 of us and demonstrated how only 20% of us would walk the stage and finish this engineering degree. While I was sitting in that seat, I thought he was just trying to scare us, but it's crazy that he was spot on. So many of my friends ended up switching majors or dropping out. Some of them had to work due to financial problems and couldn't afford to continue. Some were getting married and having kids not necessarily in that order, or not necessarily both. Some were just changing majors and said "engineering isn't for me" and switch to business. I don't think the program itself was doing or not doing anything and these challenges were relatively normal. The program itself wasn't offering resources that could have helped people outside of office hours. However, I was getting similar resources from our minority engineering program, so you had the resources if you sought them out. A lot of students who were ultimately successful ended up using the additional resources.

As I got more into my program, I realized we really do need to band together, study together, and work on this together because we can't do this alone. It was kind of hard for me because a majority of the Black and Hispanic students that I knew were all in electrical engineering or mechanical engineering. I was in civil engineering I didn't really have many people of color for direct support. After a while, this really forced me to band together with my white classmates to collaborate on course-specific work.

For example, the professors in our departments were very lazy about writing their test so they would reuse the same test cycle every five years. It reached the point where the Hispanics

might have year one and year two, the whites may have your three and year four, and maybe the Russians would have year five. Not exactly in that order.

[Pre-Critical Behavior] *For this reason, I've made it a point to be friendly to everybody, because there would be times when people would share tests. Mind you, because I was a Black student, I didn't have any versions of this test because there weren't a lot of Black students in civil. I networked with everybody because I knew I would get access to all of the stuff I needed to be successful.*

4.3.4 Scene N4: The Influence of Grad School Funding Challenges on both Pre-Critical Consequence and Non-Critical Behavior and Consequence

Space in Time- Undergraduate

Summary: In scene N4, she discussed her challenges with securing funding and how she was aware of the skewed demographics for graduate funding. She discussed how she was not able to compete for funding and was discouraged from doing anything about it because everyone else was able to succeed despite the funding challenges. In the end, she was able to secure funding through volunteer work.

Going through civil engineering, there wasn't any topic that interest me career-wise. Luckily, in my senior year, I had this random elective called fracture mechanics. I remember the instructor was an older Russian guy and the highest-paid in the department. He only taught one class and made the most by doing research. In one class he made an offer for student research, and I jumped at the opportunity to volunteer. I started doing research with him and that's what got me interested in graduate school.

I applied to the Material Science and Engineering program and got in without a problem. However, I had no way to pay for it. At {removed university name}, masters students being

funded was unheard of. You needed to be at least a Ph.D. to be funded. It doesn't matter if you're doing research or not, you're only going to be here for two years so they didn't feel like it was the best investment of their time or their resources.

[Pre-Critical Awareness] *The school itself is very diverse but when you start zooming in and looking at actual departments, that's where things start getting a little eerie. Especially as you're looking at graduate programs, it's heavily skewed towards Asian demographics and all of them were fully funded. It felt like I was being penalized for being a Black American since they didn't even give me the opportunity to compete.*

[Non-Critical Behavior] *In regards to this larger funding issue, I didn't advocate for myself and took the passive approach that this is the system I'm in and let it go.*

[Pre-Critical Consequence] *Everyone else seemed to still be successful despite this system so I made the assumption that this was how it was done. Thanks to this academic advisor, I was able to survive but I would not consider a Ph.D. program unless I'm fully funded. I couldn't take the chance of begging a professor to fund me because this process gave me a sincere distrust of the academic system.*

One day, I found myself in one of the academic advisor's offices and she suggested that I be a volunteer teaching assistant for a mentor program separated by engineering majors. I didn't have any exposure to this at all due to being isolated in the minority support engineering program, but I thought it is a great opportunity for me to volunteer and give back.

Halfway through the semester, the lead teaching assistant drops off the face of the earth. The advisor is panicking because she depended on him to help her stay organized in grading and attendance. I stepped up to organize the class and even improved the systems of organization. Through volunteering, I made myself a job. The advisor literally went to the dean of the college

and requested that I be her graduate assistant. Therefore, this is how I was able to secure funding for grad school.

4.3.5 Scene N5: The Influence of Burn Out on Non-Critical Behavior

Space in Time-Grad School and Workforce

Summary: In Scene N5, Nina described being burned out and having a lot to process and in response leaving the program to work on a psych degree.

I don't even remember walking the stage for undergrad, because it wasn't something I was socially invested in. In grad school, I was struggling with a lot of different things that were going on with my engineering program and my overall life experience. I was trying to process what happen and I tried therapy, but I wasn't connecting with the universities' therapist. I wasn't feeling heard, and it felt like he couldn't provide me with what I needed to process at all.

[Non-Critical Behavior] *I did what every bad psychologist student does, I go to a psychology program to work through my own stuff. I piled everything in my car and went to a completely different state in the middle of my engineering master's program.*

After I finished a psych program, I worked as a psychologist for a couple of years.

4.3.6 Scene N6: The Influence of Second Round of Grad School on Critical Consequence and Pre-Critical Consequence

Space in Time-Grad School

Summary: In scene N6, Nina returned to grad school due to financial demands. Now having psychologist experience she described her analysis of engineering work as something that feeds into capitalism. Furthermore, she went on to describe her isolation in grad school and blamed this isolation on the PWI environment.

I got married and had to come back to engineering. My husband has expensive tastes and I had to figure out how to finance those expensive tastes. Although the psych degree makes me happy, it doesn't finance expensive taste, so I enrolled in graduate school for the second time. Now that I also had my psych degree it gave me a different perspective on engineering. As I went through my Industrial Engineering program, I noticed they start caring about what people think.

[Critical Consequence] As a psychologist, I felt I was making a difference by reuniting families and dealing with substance abuse. With engineering, I felt like I was lining some white guys' pockets more than I am making a difference.

This time around in grad school, I was by myself, and it was the most abysmal experience I've ever had. My class was half Indian, half Chinese, and one or two white people. They weren't really trying to do much studying outside of class at all. They focused on getting their work done and going home. Due to my full time job, I really didn't have access to office hours; When I did make it to office hours, I felt that the TAs were not helpful.

[Pre-Critical Consequence] At {university} there were like two Black students in two different classes that I was in and I approached them to study together. However, it felt like there was this fear of loss associated with the other Black students and they didn't want anyone else to associate us with each other. Due to my terrible experiences at PWIs, if I ever did another degree in engineering, I'll enroll in an HBCU because I refuse to go to another PWI. At an HBCU, I don't think I would have as many barriers to finding other people to study with that belong to my shared culture.

4.3.7 Scene N7: Influence of Supervisor Investment on Pre-Critical Consequence

Space in Time-Workforce

Summary: In scene N7, Nina finally found fulfillment in a role and attributed her sense of purpose to her supervisor.

I was able to do an internship with {removed electric company name} that involved wire-down responses. At the time of my internship, they already had a number of deaths from exposed wires and were being audited. Initially, I didn't realize how much work I was doing to save lives until I actually started it. {The electric Company} covered millions of people and their service area is so vast. I found security when I realized my engineering background and expertise could be used to look at processes from various angles and analyze data to try to understand what went wrong so that it can be improved. Also, I didn't realize that my psych background would come in handy when I'm dealing with the managers of each of these respective processes and communicating effectively.

This was the one job throughout my entire career where I felt like my supervisor had a vested interest in my career trajectory and took on the responsibility of coaching me. She was a white female, but she was also a part of the LGBTQ community; So, while not being a POC, she understood how it was being marginalized, because she was presenting as a member of the LGBTQ community. She introduced me to project management, and I've been in it ever since.

[Pre-Critical Consequence] I finally had my aha moment where I knew where I wanted to be and what I wanted to do. I loved the team that I was on and the mentorship and everything about this position were just phenomenal. Having bosses who are that vested in you is so few and far between, but I was so lucky to have this experience. I went on to being an entrepreneur that prioritizes people and incorporates diverse factors to be an efficient leader in this field.

4.4. Voyage 3: Penguin

Penguin is a Black woman who professionally identifies as a professional civil engineer. She is located in the western region of the United States. She is a Black woman whose highest formal school level is a master's in civil engineering. Penguin was selected for this study because she is passionate and interested in learning more about serving communities through equitable infrastructure. Currently, her engineering work is situated in industry, and she is also exploring equitable infrastructure through entrepreneurship.

Table 9. Penguin's Scene Guide

| Scene # | Timeline | Critical Incident | Sociopolitical Level | Sociopolitical Domain | Sociological Ecosystem |
|---------|---------------|--|----------------------|----------------------------------|------------------------|
| 1 | K-12 | Witness engineering guest speakers | Non-Critical | Awareness | Exosystem |
| 2 | K-12 | Partake in engineering community service class project | Non-Critical | Awareness | Microsystem |
| 3 | K-12 | Experience microaggressions in an engineering classroom | Critical | Behavior, Consequence | Interpersonal |
| 4 | Undergraduate | Navigating engineering curriculum | Non-Critical | Awareness | Macrosystem |
| 5 | Undergraduate | Participate in study abroad in Japan | Critical | Awareness, Consequence | Microsystem |
| 6 | Undergraduate | Participation in a project that with a direct impact on residents in the community | Critical | Consequence | Exosystem |
| 7 | Undergraduate | Participation in an unconventional farming project | Critical | Behavior, Awareness, Consequence | Exosystem |

| | | | | | |
|---|---------------|---|------------------------|-----------------------|---------------|
| 8 | Undergraduate | Preparation for the transition from school to work | Non-Critical | Behavior | Intrapersonal |
| 9 | Workforce | Witness government initiatives for infrastructure projects in disadvantaged communities | Non-Critical, Critical | Behavior, Consequence | Exosystem |

4.4.1 Scene P1: The Influence of Role Models on Non-Critical Awareness

Space in Time-K-12

Summary: In scene P1, Penguin describes how she became interested in engineering due to a guest speaker inspiring her to believe that she could make a positive impact on the community. She based her entire career on this perspective and lacked any critical thought about social forces around engineering.

My initial interest in engineering started in the seventh grade. I went to a specialized STEM institution in middle school that encourages kids to pursue careers in engineering and science. The curriculum was probably the same as what you'd get at a normal standardized school, but the school was pretty intentional about bringing in guest speakers every couple of weeks to talk about their career paths and work experiences.

[Non-Critical Awareness] *My interest was captured by hearing various guest speakers discuss the positive impact they had on their respective communities. Even in middle school, at that time, I wanted my future career to be something that I could make a positive difference in the lives of people and saw engineering as a potential career path to be able to do that given my interest and strong skillset in math and science at that age.*

By the time I decided to pursue engineering, I had countless examples to reference of people who use engineering to help improve the community. While my path may have looked a little bit different, It gave me comfort knowing that I'm not charting a new path. I'm just going in the way that works for me. Since I have seen it done before I had the basis and foundation of the internal drive toward becoming an engineer.

4.4.2 Scene P2: The Influence of Engineering Community Service Class Project on Non-Critical Awareness

Space in Time-K-12

Summary: In scene P2, Penguin describes her participation in extracurricular activities and engineering courses. Within the engineering course specifically, they did a community service project and mentioned not thinking about the underlying social forces.

I have a lot of extracurricular interests between sports and music, and the school had promised to get it {extracurricular activities} set up for students, but it never really happened. Therefore, I made the decision to go to a traditional high school that was actually closer to where I lived because this specialized middle school was not particularly close to my house. This high school had a specialized engineering academy within the school itself where I could opt to be in this engineering tract and take engineering focused classes, in addition to the standardized high school requirements. I opted to participate in the engineering program because of the positive experiences I had in middle school. In addition, I was able to continue to explore my interest in music, sports, and foreign language as well. In this transitional period, I appreciate that I was able to grow in my identity and all the different facets of my life.

In junior and senior year, we started doing group community service projects with woodworking. One year, we built a mini closet, like a portable coat hanger rack, for an

elementary school teacher. This brought my interest in wanting to help improve the community that I discovered in elementary. In addition, it brought in teamwork, engineering ability, and listening to your client through design.

In the class, we paired up into our own groups, and I had two really good friends in the class. Our first task was brainstorming which community entity we would work with. Based on our respective involvement in the community, we decided to go with my friend's favorite elementary teacher who mentioned they don't have anywhere proper to hang up their coats. I think it was something like with budget challenges, and they needed to get pencils and didn't have money for coat hangers. It's been an elementary school for a long time, so you would have thought there would have been some old coat hanger somewhere, but apparently not.

[Non-Critical Awareness] We took the tactical approach of supporting this one teacher, and I don't think any of us were in the mindset to think about the broader equity issues associated with that. We're just thinking we need to get this done for a project.

4.4.3 Scene P3: The Influence of Microaggressions on Critical Behavior and Consequence

Space in Time-Grad School

Summary: In scene P3, Penguin describes the overt discrimination she experienced as she engaged in her engineering course and how she devised a plan to address this issue by writing a letter to the administration and correlated this experience with common inequities she faced along her journey.

For my immediate team, all three of us were ladies. In this class, the gender differences were way more apparent given that the class was majority boys, and the three girls were all on one team together. There definitely was a lot of gender bias at play with other male students in

the class saying things like, “three girls can't build a nice sturdy bookshelf for this elementary school.”

I got a bit heated in class because we spent three months working on this whole project from start to finish. We were day in and day out, putting in work, working alongside our classmates, and people are making snarky comments about the entire time.

It was a bit challenging to deal with the comments, but at the same time, we had support and camaraderie within our internal team, and we persevered through it all. My mom also encouraged me not to let snarky comments dissuade me from pursuing my interest or my goals. I felt supported in doing engineering by my mom and family and continued on the engineering path despite the bullying.

Unfortunately, this bullying came up in other avenues. In the classroom, people were saying that certain people are getting opportunities only because of affirmative action.

[Critical Behavior] I would tell my mom and she helped me craft a plan to bring the issues to the administrative staff at the school so that we could actually bring about some course of action. I was learning how to advocate for myself earlier due to these challenges in high school and it lead to me eventually having high self-esteem. We wrote a letter to the principal and dropped it in his mailbox at the school. This led to a one-on-one conversation with the school principal who basically said “we can't do anything because no one made an explicit threat against you, but we've noticed that this is not conducive to the type of student body we want to have.” As a result, no disciplinary action was taken but I think it was eye-opening for me. I learned how to devise strategies for issues where there is multiple staff involved and an individual issue needs to be resolved.

[Critical Consequence] *I have all these experiences in my past to look back on that relate to inequity or injustice and I am aware that it is a thing. I learned how to navigate people who have different personalities and different motives. After time passed, these instances were not a big blow to me, because I had people not be particularly supportive in my past. Since I'd had those experiences in high school, the new experience would just roll off my shoulder. Were they challenging? Yes, but I made it through them. I think I had more resilience to move forward in the future.*

4.4.4 Scene P4: The Influence of Choice of Major on Non-Critical Awareness

Space in Time-Undergraduate

Summary: In scene P4, Penguin explains how she went to a college where she can be her full self and choose her major based on her experiences with the faculty in that department. As she navigated the engineering curriculum, she noticed the separation between people problems and technical problems but she couldn't recall when she made this assumption.

Among all of the post-graduate plans, I started considering colleges and my strong interest in extracurricular areas. Some of the universities that I was looking at made it clear that if I was coming to study engineering, I was only going to have time to do engineering. I still wanted to play in a music ensemble and take a foreign language class. The university I ended up going to for undergrad, was on the smaller side, but way more flexible academically to allow for people to pursue interests in different areas. Although the Black population was 2%, I don't think it was much of a culture shock personally because of my exposure to discrimination in high school.

My parents don't have college degrees, but they're super supportive of my journey. I conducted informational interviews with upperclassmen and professors to gain insight into the

discipline that was best for me. After interviewing classmates and professors, I settled with civil engineering because I felt like I connected better with the civil engineering faculty at my university. I progressed through my classes normally and took them year by year because making it to the next academic year was a miracle in itself. I was one of those students that were overextended with extracurriculars, but I think that helped me grow personally.

[Non-Critical Awareness] *When I was in college, it was more of a separation between people's problems and technical problems, which don't really overlap. Especially if you are dealing with institutions, whether it's government or universities. I don't really know how I previously made that separation or when the separation started to break down, but I think it's a little more intertwined in my head now than it was before.*

4.4.5 Scene P5: The Influence of Study Abroad on Critical Awareness and Consequence

Space in Time-Undergraduate

Summary: In scene P5, Penguin discussed her experience in Japan for study abroad and she became aware of rural areas and the impact of disasters. This awareness pushed her reflect on the separation between people problems and technical problems and she came to the realization that you cannot have one without the other.

A pivotal experience that shift my mindset towards becoming more aware of social inequities was spending six months studying abroad in Japan during my junior year of college. It was an eye-opening experience because I realized that there are a lot of very similar engineering challenges between Japan and California. By being in Japan, I was exposed to the similarities of inequities that exist.

[Critical Awareness] *I found it particularly interesting that more rural areas didn't have access to certain resources. Especially with disaster recovery, including response to earthquakes*

and tsunamis, where certain areas get rebuilt faster and better than others. This didn't really cross my mind beforehand. However, hearing about the historical disasters helped opened my mind to these versions of inequity in different systems when it comes to actual physical infrastructure in society.

[Critical Consequence] I did some personal reflection on my time In Japan, and how it has been a good experience. I think it made me more considerate of social interactions by being in Tokyo, a mega-urban. At the time, my reflections focused on the technical aspects and less on the social elements, but I still found these observations interesting. Before my time in Japan, the separation between people and technology was largely due to how engineering was framed in an academic context in America. When studying engineering, you're solving technical problems and the technical evaluation is the only thing that matters. The technical perspective is a very narrow kind of lens. The nature of these problems were not cut and dry as my American professors presented them.

Whereas, in Japan, I heard different perspectives on engineering challenges in various context. I felt just the social consideration was more there. However, I think that it was a function of some of the professors that I had had while I was there. For example, I took a sustainable development class, and the professor from that class was Japanese, but spent a fair chunk of her career in Australia. Therefore, she always brought up these examples of how there's so much unsustainable development in more developed nations. The professors were very intentional about making the direct connections between the technical issues and the social issues. This insight pique my interest and allowed me to make sense of how social and technical issues are more intertwined than I initially thought.

4.4.6 Scene P6: The Influence of Cooperative Education on Critical Consequence

Space in Time-Undergraduate

Summary: In scene P6, Penguin discusses the influence of her co-op once she returns to American and after Japan, she was more aware of social forces and wanted to understand this in engineering practice. During the internship, she noticed the rush aims of industry and the integrated nature of technical and social elements.

As I was coming back from Japan, I did an internship at a wastewater treatment plant, not too far from where I live. And as a sidebar, my university has a Cooperative Education Program (co-op). So rather than taking classes for a semester, you go work as a full-time employee at some organization for six months to basically learn how engineers operate in the real world.

[Critical Consequence] *While at the internship, the plant had some issues getting some recycled water projects approved, because they were pissing off the people that lived on the backside of the area where the recycled water pipelines would be expanded. The agency was trying to shoehorn the project to meet a funding deadline which didn't go over well because they didn't build in time to talk with the neighbors to hear and understand their concerns. If they did build in this time, they could come up with a solution that would work for all parties involved. Anything that deals with people is not as cut and dry as doing calculations and it must be accounted for in project considerations. This was another example of where I saw these technical and social elements melding together and noticed that you can't deal with them independently. As my awareness grew of the challenges surrounding this one project, I started to chip away at this hard separation between social and technical and brought more awareness to their intertwined nature.*

4.4.7 Scene P7: The Influence of a Non-Traditional Internship on Critical Awareness, Behavior, and Consequence

Space in Time-Undergraduate

Summary: In scene P7, Penguin described her experience in what she called an “unconventional” internship where she was able to participate in selling produce to fund food disparities. Through this, she became aware of “unconventional” paths of addressing inequities and evaluated her agency in combating social inequities.

Another pivotal experience to think about after the wastewater treatment plant, but before I went back to my school for senior year, I took an unconventional path. I did a summer internship with an urban farming entity in {my local area}. The urban farming entity took over an unused Blacktop out of high school and put a half-acre farm on the backside of a high school. There's a lot of rhetoric around food deserts, and the people who worked at that urban farm were helping combat food deserts by feeding the people who live nearby the community. However, It's not like a one size fits all solution. They didn't ask for permission from the school or district and worked with a math teacher at the school to get it done. They started growing food and feeding the community around the school with the produce from the garden.

[Critical Behavior] *Then, we went to sell produce at the farmers' market in the more affluent areas in order to reinvest in this farm to help combat different socioeconomic inequities in this particular area. Until now, I didn't consider how farming was an impactful solution to combat inequity.*

[Critical Awareness] *It wasn't engineering related and helped me expand my mindset on how different issues are interconnected. It seemed pretty wild to me that they were doing this*

unconventional farming that probably could have been illegal, but they didn't care. They saw the broader need for serving the community and just did it.

[Critical Consequence] *This whole experience opened my eyes to systematic avenues to solving problems in an unconventional manner. Before this experience, I saw inequity as a thing that existed outside of me. I didn't really have a lot of clarity on how it just came about; it was something that exists and has always existed, and you just kind of manage it. Whereas afterward, I think some of that sentiment was still there, but I felt more personal empowerment to do something to help combat it. I know I can't solve the whole issue by my actions or even my team's actions. However, I knew people's efforts to combat inequity can make a positive difference, whether small or big.*

4.4.8 Scene P8: The Influence of Preparation for Transition from School to Work on Non-Critical Behavior

Space in Time-Undergraduate

Summary: In scene P8, Penguin is finalizing her senior year but she is not faced with internal conflict about pursuing professional engineering work.

Transitioning out of summer with the urban farming people and coming off the time in Japan, I was going into my senior year of college. I was happy I made it to my senior year of college, but then I started having this mid-life crisis. I have all these interests in these other areas and questioned whether I even want to be an engineer. Most of my collegiate academic experience had been so heavily focused on the technical aspects and I realized that my interests were more on the non-technical aspects. I remember feeling really conflicted because I spent all this time and effort on engineering and it isn't actually what I want to do.

[Non-Critical Behavior] *Despite the conflict, I continued to work through my courses and started applying for just regular engineering jobs. Since I did all this work, doing nothing was not an option. I didn't put a lot of thought into desired characteristics of an employer. I just went off the recommendations of other past students who were recruited to go work for their respective companies. I arbitrarily applied for jobs all over the place and ended up getting hired by a company that worked primarily on water and wastewater projects for municipalities.*

So that's how I kind of went from finishing college into the professional working world. However, I only stayed with that company for nine months and went to go find another job due to a variety of factors that contributed to a toxic working environment.

4.4.9 Scene P9: The Influence of Engineering Workforce Reflections on Non-Critical Behavior and Critical Consequence and Behavior

Space in Time-Workforce

Summary: In this scene, Penguin was transparent about not providing an equity lens to work in the beginning; however, she is now noticing more opportunities to integrate equity due to government initiatives for underserved populations. She describes herself as a cynic and explained that despite being hopeful, she is not confident much will change. Her desire to address inequities oscillates back and forth, but as she reflects on her personal path, she has a sense of responsibility to address equity issues.

[Non-Critical Behavior] *When I first came into this particular company, I wasn't intentionally bringing equity considerations to the work that I did. However, I think I've found opportunities to incorporate them throughout the years. Frankly, it's not as intentional as I would desire it to be, but I view it as playing the long game.*

In the past year, there's been a focus on shaping projects to help support disadvantaged or under-resourced communities, in light of the bipartisan infrastructure law. There are explicit provisions in that bill to fund projects to help support those vulnerable populations. Therefore, it appears to have a strong spotlight to incorporate equity in our infrastructure projects. Some of those considerations were probably already there but it's in hyperdrive due to the explicit language in this piece of legislation.

[Critical Consequence] *A part of me is excited but the cynic in me says it's not going to make a difference. The same communities that are already getting funded and are getting projects will continue to get funding. It is my hope that this starts to kind of shift the way people think about implementing infrastructure, but we have a track record of wasting state and federal funding for infrastructure. My concern is that that same thing will happen here, whether there's money earmarked for vulnerable populations or not.*

[Critical Consequence] *For instance, my company has started various initiatives to do more projects in these under-resourced communities and partnered with grassroots community organizations that are closer to the need of these vulnerable populations. However, my company doesn't have the technical expertise to know exactly what the issues may be, or maybe what the long-standing historical issues have been. They have been expanding partnerships to work with people with first-hand knowledge and hopefully implement a solution that works for communities. On the other end, I have worked on some projects that attempt to spin how the project is presented to check a box on meeting funding requirements for disadvantaged communities. These actions have not sat with me well, because they are doing it just because they want a check from the federal government, not because they're really solving a need for a*

vulnerable population. This is not done across the board, but there are initiatives for different communities largely based on the staff, and customers' desire.

[Critical Consequence] As I reflect on my personal path to becoming an engineer, I remember that I entered this field to help people. This motivation comes full circle when engaged with projects that provide a direct benefit to vulnerable populations. As a Black woman who has made it to become a civil engineer and done pretty well, bringing an equity lens to the work that I do is a responsibility moving forward.

Unfortunately, I haven't been very intentional about doing that as of yet, but this is my drive and long term. I am optimistic about how society is changing to be more generally inclusive of different folks and how these different factors will culminate in shifting how we do engineering holistically moving forward. However, right now, we're in this shifting standpoint where it will take time for this stuff to play out.

In the consulting world, your clients hire you to get a job done and there isn't a lot of space, both time and budget-wise wander outside of those parameters. Therefore, sometimes it feels like there are guards in place that kind of keep you from thinking about the bigger picture and thinking more holistically. However, I fight against this sometimes because I need to honor the fullness of who I am. Honestly, the desire to address social justice at work oscillates back and forth depending on the day. However, my vision is to see people from various backgrounds come together and collaborate on an equal playing field to solve various existing issues. A lot of these problems are complex, and you're going to need different types of thinking, to navigate through them. A group dynamic where everyone has an equal opportunity for input is what more equitable problem-solving could look like in the future.

I've only been in the workforce for five years, so my views are still evolving. However, compared to how I felt when I first graduated college to where I'm now, I knew that bridging this technical and social gap was an interest of mine, but I had no idea how to actually do it. Whereas today, there's a better understanding of how I could do that, whether it's through project work or volunteering, or any kind of intentional actions. The path isn't so vague and unclear now as it has been in the past.

4.5. Voyage 4: Richard

Richard is an Afro-Caribbean man who professionally identifies as a project manager, planner, researcher, and educator. He is located in the Mid-Atlantic region of the United States and his primary engineering degree in Civil Engineering and the highest level of formal schooling is a doctorate. Richard was selected for this study because their engineering contributions surround the entire disaster life cycle (planning, preparedness, response, recovery, and hazard mitigation). Currently, his engineering work takes place in the context of industry, academia, and government sectors.

Table 10. Richard's Scene Guide

| Scene # | Timeline | Critical Incident | Sociopolitical Level | Sociopolitical Domain | Sociological Ecosystem |
|----------------|-----------------|--|-----------------------------|------------------------------|-------------------------------|
| 1 | Childhood | Raised in a sheltered environment | Non-Critical | Awareness | Mesosystem |
| 2 | K-12 | Duel enrolled in high school and a local university engaged in both liberal arts and engineering | Critical | Behavior | Macrosystem |
| 3 | Undergraduate | Enrolled in civil and environmental | Critical, Pre-Critical | Consequence | Interpersonal |

| | | | | | |
|---|-----------------|---|----------|---------------------|--|
| | | engineering in a PWI environment | | | |
| 4 | Graduate School | Participated in Black graduate organizations | Critical | Awareness, Behavior | Microsystem |
| 5 | Graduate School | Exposure to advisor's and graduate students' research on emergency management | Critical | Awareness, Behavior | Intrapersonal, Macrosystem, Chronosystem |
| 6 | Workforce | Work in a government agency and directly experience community involvement | Critical | Consequence | Mesosystem |

4.5.1 Scene R1: The Influence of Home Environment on Non-Critical Awareness

Space in Time-Childhood

Summary: In scene R1, Richard describes his home environment as sheltered which influenced his acknowledgment of identity and lack of connection with marginalization. He brought in an Afro-Caribbean perspective of Blackness that wasn't situated in whiteness. Near the end, he describes himself playing video games which led to an interest in engineering.

My journey starts pretty young. I grew up in a very protective home. I knew things were happening outside the home regarding identity and marginalized communities. I was probably not using that terminology at that age, but I was able to acknowledge it. However, it wasn't something that I felt directly impacted me.

[Non-Critical Awareness] *I did not see myself as a low-income, first-generation American, growing up in Brooklyn. In terms of Blackness, there's a different perspective on what*

it means as an Afro-Caribbean. I was raised in a culture where Blackness wasn't necessarily something to be taught. My Blackness was something that was there that I acknowledged and respected, but it wasn't framed in the context of whiteness. Of course, whiteness is there given by the Queen of England, but it's a little different. I was surrounded by Black people until I went to high school.

As most kids, I engaged in different activities, and I loved video gaming. I used these video games to escape my reality. The game I loved most was the Sims because I could create worlds on a computer screen. This game got me excited in terms of engineering and ways to build virtual environments.

4.5.2 Scene R2: The Influence of Multidisciplinary Curriculum on Critical Behavior

Space in Time-Grade School

Summary: In scene R2, Richard describes his first encounter with engineering concepts alongside liberal arts in high school, taking associate-level courses at a nearby university. Through this curriculum, he discussed his appreciation for liberal arts and integrating learned skills in technical courses and subsequent texts.

I gained my first real exposure to engineering through an introductory engineering class in high school. While in high school, I went to a nearby university where I obtained my associate degree alongside my high school degree. I had my introduction to engineering course and explored different subjects and engineering incidents, from the Challenger to major catastrophes.

[Critical Behavior] *During that time, I was being able to explore different subjects, both on the liberal arts side as well as the STEM side, which I think really has shaped my career and approach to engineering. I was constantly reading, writing, and communicating. In this space, I*

learned the importance of liberal arts and its relationship with technology. For me, the connection has always been strong. Even in technical courses, we wrote engineering reports, problem statements, theses, results, and conclusions. The liberal arts have always shown me it's important to understand the use of communication, its history, and its connotations.

[Critical Behavior] I even analyzed my textbooks and noticed the white authors' backgrounds. When it came to perceiving certain things in engineering, I knew it was from that author's lens. I take this skill with me in the workforce to communicate effectively and identify the perspective my audience is coming in with. I really think you can't have social elements without technical ones.

4.5.3 Scene R3: The Influence of PWI on Critical and Pre-Critical Consequence

Space in Time-Undergraduate

Summary: In scene R3, Richard describes himself as being attracted to transportation engineering due to its social interface with the public. Once enrolled in the program, he discussed the challenges of the curriculum and being the only black person in his classes.

From my dual enrollment experience, I knew I wanted to attend college and study engineering. In college, I realize there were more specializations within civil engineering itself, from structural to geotechnical. Transportation captured my interest mostly because of the social nature that everyone experiences surrounding transportation. Whether they use public transportation or drive, this topic connects us. On top of this, I really enjoy the engineering behind the whole transportation process.

[Critical Consequence] During my undergrad, the engineering curriculum primarily focused on environmental and structural. I believe the most important part of engineering is your ethics. Therefore, understanding the ethical implications of your role and responsibilities in

relation to society. However, the engineering curriculum, the way we do engineering, and the way we teach technical skills need to improve. Starting from the top down, I would say that America, as a country, has fallen way behind the terms of how we teach students and how we produce thinkers and problem-solvers. Then, when it comes to engineering, we're teaching these highly technical courses, and we're cramming a lot of information in a short period of time. I just think that the engineering education system just needs to examine that because there is more room for ethics. I think it's not that you just teach one course, but there should be an ethics component integrated into all courses taught. For instance, if I'm taking a structural class, there should be an ethnic component regarding how buildings are designed in America versus how they're designed in Haiti.

For most students, if you were pretty good in high school, you assume you would have the same results in college. However, it was definitely a challenge to adjust to the rigor, but I would say that was probably more prepared than most.

[Pre-Critical Consequence] The biggest challenge is the cultural environment of going to a predominantly white institution and being the only one in many cases. On top of this, the majority of my teachers were white males. Whether within the seminar class or in the engineering classroom, I found myself always dealing with those dynamics. I attended an all-minority school until high school, so college was my first exposure to a more diverse environment. Through this culture shock, there were moments when I became more aware of the duality of who I am, how I look, and how people perceive me. I had friends who were not minorities, and develop strong relationships, but there were moments when I realized I would never be as close to them as their white counterparts just because of their life experiences alone. Even from the outside in, I noticed how they would interact with each other versus how they

would interact with me. Some of this could be all perception and not necessarily real, but I have these moments all the time. It helped to participate in a cohort-based program that recruited students from urban settings to attend these predominantly white institutions.

4.5.4 Scene R4: The Influence of Black Organizations on Critical Awareness and Behavior

Space in Time-Graduate School

Summary: In Scene R4, Richard describes himself as finally being able to identify the social elements surrounding engineering practice. Also, he got connected to a large network of Black professionals who introduce him to the “fullness of the diaspora.” The organization exposed him to the sense of responsibility he has as a Black professional while also teaching him to be proud of his blackness.

Since there weren't many opportunities to be able to explore transportation, I knew graduate school was a good option to become more specialized. Graduate school was the first time that I was able to see how liberal arts and social science were infused into engineering. I contribute this new awareness largely to the first time I had a larger network of Black professionals.

I went to a predominantly white institution for undergrad and graduate school, but I was really able to find a group called the Black Graduate Student Association at {removed university name}. I've got to share the horror stories of other students and the relationships that they had with their advisors. Their advisors didn't believe in them or the work that they were doing. This was the first time I really got to explore those types of experiences within the academic environment, and I was able to just learn about people's social experiences around the fullness of the diaspora in being Black and being proud.

[Critical Awareness] *This organization shaped my experience, and I gained an understanding of what it means to be Black, in academia, in engineering, and in the professional field. Before this new understanding, it was just me being a student in engineering. Transitioning from a student to a professional gave me additional perspective.*

[Critical Behavior] *From the new awareness, I grew in understanding of the role I need to play as a professional. I adopted the view that it is my responsibility to help and support other minority engineers along the way.*

4.5.5 Scene R5: The Influence of Graduate School on Critical Awareness and Behavior

Space in Time-Graduate School

Summary: In scene 5, Richard described his present awareness of social inequities and how grad school deepens his understanding of the underlying causes. Furthermore, he acknowledged the dismissiveness surrounding engineering's social consideration and how this influenced his behavior of creating the space to have conversations around social justice in engineering work.

I grew a lot in my understanding of the social nature surrounding transportation engineering in graduate school. I was introduced to this field through my advisor who worked at the university and in the government sector. I would say academia prepared me to address solely technical engineering issues. However, it was my experience that allowed me to fulfill a social justice lens on engineering work.

[Critical Awareness] *As I got exposed to negative experiences and discrimination through multiple avenues of everyday life, I realized the disadvantages that I have along with others that look like me. I already knew that vulnerable communities are the ones that suffer the most, even though when it comes to disasters, everyone is suffering. Grad school informed and*

expanded my perspective through exposure to the research being done and how people experience various inequities.

[Critical Awareness] *Anytime social justice came up in the academic space they viewed it as ancillary. For instance, they would say, “don't forget to be ethical here” but it wasn't the main part of engineering. I was interested in understanding the system dynamics surrounding transportation. Especially being from New York City and living in an urban environment. I grew up as a first-generation American and my family is originally from South America. I would say that because of this I had a reserved childhood. I came in knowing that there are differences in different types of transportation systems and the various impacts of disaster response in communities but exposure to research deepened my understanding.*

[Critical Behavior] *When I wanted these conversations to take place, they were self-created versus it being done directly by the institution or the organizations I was a part of. Also, I was able to learn a lot just by interacting with other students around the field and being exposed to their research.*

4.5.6 Scene R6: The Influence of Disaster Management on Critical Consequence

Space in Time-Workforce

Summary: In scene 6, Richard explains how his views on his job developed from a thing he needed to do versus his responsibility to bring voices in the room that were not present. In his analysis of his role in work, he believed government was a space he could make the most impact since he is constantly refining his knowledge about the ways engineered systems impact vulnerable populations.

I think for a long time, my relationship with my job and work was just defined by what I'm assigned to do and getting the job done so I can go home at the end of the day. However, in

my silence, I realize I do have a responsibility to be the voice of those that aren't in the room. There aren't a lot of people that look like me in these spaces that alone is a position of power. Of course, this comes with challenges that impact my career and my future. However, that's the role I realized I must take on in addition to doing my actual job.

[Critical Consequence] *I saw government as a way to make the most impact because I saw how they directly affect the shape of people's lives. Every day I learn something new about systems, how they are built, and how they impact Black people. For instance, I have witnessed lived experiences by working in a service center where people are coming from Puerto Rico because they no longer have a home. Having that firsthand experience, but also knowing what the research says about Katrina, Maria, and the heat waves, I know that disasters impact us. For me, it's really about the focus on the most vulnerable populations that have been impacted by climate change and the issues that they face every day. Even something as simple as residential parking has a racial and equity component. I constantly learn about vulnerabilities through research and doing the actual work. I think there's so much to be learned.*

4.6 Voyage 5: Vee

Vee is a Black woman who professionally identifies as a social equity and environmental justice practitioner, environmental engineer, and people person. She is located in the southeast region of the United States. Her primary engineering degree is also Civil Engineering and her highest level of formal schooling is a master's degree. Vee was chosen for this study because she works at the intersection of engineering services and social contexts. It is her aim to increase equity in the distribution of opportunities, resources, access, and dignity of the people who engage with the engineered systems. Currently, her work takes place in the context of industry and government.

Vee would describe herself as a person that always has a genuine love of people. In her narrative, she depicts her natural inclination to be able to listen, understand and empathize with people. She stated, “if you let my mom tell it, she used to have to worry about me, running off with strangers in the grocery store and wanting to hug everybody”. She shared her need to connect with people and create welcoming environments and described it as “God's gift” to her.

Table 11. Vee's Scene Guide

| Scene # | Timeline | Critical Incident | Sociopolitical Level | Sociopolitical Domain | Sociological Ecosystem |
|----------------|-----------------|--|-----------------------------|--|-------------------------------|
| 1 | K-12 | Witness engineering guest speakers on career day | Non-Critical, Critical | Awareness, Consequence | Intrapersonal |
| 2 | K-12 | Identified exclusionary practices in the talented and gifted program | Critical | Consequence | Exosystem |
| 3 | Undergraduate | Discovered the NSBE community and their mission | Critical | Behavior | Microsystem |
| 4 | Undergraduate | Navigated general courses within the engineering curriculum | Pre-critical, Non-Critical | Awareness, Behavior | Interpersonal |
| 5 | Undergraduate | Participate in study abroad in South Africa | Non-Critical, Critical | Behavior, Awareness, Behavior, Awareness, Behavior | Microsystem |
| 6 | Undergraduate | Witnessed humanitarian efforts from a local perspective | Pre-Critical | Consequence | Exosystem |
| 7 | Undergraduate | Processed the murder of Treyvon Martin | Critical | Awareness, Behavior | Chronosystem |

| | | | | | |
|----|-----------------|---|------------------------|------------------------|----------------------------|
| 8 | Graduate School | Processed the continuation of police brutality after enrolling in graduate school | Critical | Consequence , Behavior | Macrosystem |
| 9 | Graduate School | Gravitated to the broader Black community and exercised liberated conscious | Critical | Behavior | Intrapersonal |
| 10 | Graduate School | Drained by life demands and required recharging | Non-Critical | Behavior | Intrapersonal |
| 11 | Workforce | Practice self-care | Pre-Critical | Awareness | Intrapersonal |
| 12 | Workforce | Aligned personal values with engineering work | Pre-Critical, Critical | Consequence , Behavior | Intrapersonal, Microsystem |

4.6.1 Scene V1: Influence of Career Day on Non-Critical Awareness and Pre-Critical Consequence

Space in Time-Grade School

Summary: In scene V1, Vee describes how her interest in engineering was captured by a guest speaker and his presentation that positioned engineering as an opportunity to be a part of something bigger than herself. She continues to reflect on what it means to her to pursue a career linked to the environment and the constant positive reinforcement of pursuing an engineering degree.

In middle school, I made the decision to pursue engineering. One day we had a career science day, and we had several folks come in to share their career experiences with us. This

career day also took place during Earth Week, and an engineer came to speak to us about using recycled materials to create an engineering solution.

[Non-Critical Awareness] I was attracted to the sustainability and positive impact the guest speaker said he made on the community. In addition, I excelled in math and science. At the time, people heard engineering and said it would be a stable future for me, and I would be able to provide for myself financially. I didn't receive the same positive reinforcement I initially had when I said I wanted to be a children's book author.

[Critical Consequence] As I think back, even at this age, my interest was captured by the link to the environment, something that felt more tangible, something that felt like I was still connecting with people. But as I've been reflecting, I think there is still this kernel of doing something that improves the environment and is much bigger than yourself. I'm still contributing to something that's overwhelming and simultaneously yields financial stability, which may be what my life at that point had no experience with. However, I needed to take care of myself and be a part of something broader than myself. A combination of the positive reinforcement and perception of a career in engineering from my environment led to my decision to pursue an engineering career.

Once I decided to be an engineer, I never considered anything else for the next 20-plus years. I researched what I needed to apply to colleges, and my path was set on Civil and Environmental Engineering.

4.6.2 Scene V2: Influence of Gifted and Talented Program on Critical Consequence

Space in Time-Grade School

Summary: In scene V2, Vee discussed her ill feelings around being in the “special and talented” space since this also meant she was separated from peers that look like her. By

reflecting on this experience she also recognized that all of the guest speakers that visit her class were also white. This separation led to her desire to be around Black people that were high-achieving and free to exist in their own spaces.

Throughout my K-12 journey, I was selected to be in the talented and gifted program. When they start pulling you out as “special and talented” and place an extra investment in you.

[Critical Consequence] I initially believed I was placed in “special and talented” environments due to my own efforts. Over time, you start to see those spaces don't necessarily reflect an even split of the overall school. In this exclusive space, I became the minority in that way. As I got into the honors and AP courses, I found myself again in a group that didn't match the demographics of the overall school. At the time, I didn't have the words or research I have now, but I could still feel like it didn't make sense. I now know these spaces were skewed toward whiteness. I knew those kids outside of honors and AP courses because they lived in my neighborhood. I would hear teachers talk negatively about other students that weren't considered “talented and gifted,” and I knew they were smart. I always felt the wrongness/achiness about it, and I took this feeling with me as I searched for safe spaces in my engineering undergraduate experience.

Going back to my memory of STEM career day, I remember that all the engineering guest speakers were white. Once I decided to be an engineer, that led me to want to be more in a space of Black people who were quote, unquote, high achieving, and motivated. Where Black people just were themselves, not trying to be anything other than themselves.

4.6.3 Scene V3: The Influence of NSBE on Critical Behavior

Space in Time-Undergraduate

Summary: In scene V3, Vee discussed her disconnection from the women's engineering dorm and finding NSBE (National Society of Black Engineers). Through NSBE, she was able to be involved in social justice and equity work. This work affirmed her purpose in the engineering space.

I lived in a dorm for women in engineering, so there was always programming for us to feel supported in a predominantly male-dominated field. It was where I lived, but it didn't connect with me.

In my second semester of freshman year, one thing that immediately hooked me was finding NSBE. I was like, "Oh, they Black Black." It was an affirming space that I hadn't yet experienced in that way and didn't know I needed it. NSBE members were doing engineering in a way that I could relate to on greater levels than solely the science, technology, engineering, or math lens.

[Critical Behavior] *From there, I found an application of being involved in social justice or equity work and asked, "how do you make space for people and resource them to feel empowered to navigate these spaces that aren't always welcoming specifically to Black people?" I started to get heavily involved with NSBE, and this space became the greater good of my engineering career. I had two different leadership ranks throughout the organization and spearheaded much outreach, specifically to minoritized students. This consisted of positive affirmations encouraging students that looked like me by saying "you can do this", and "let me help you." To me, this meant wedging up the door and providing the resources and encouragement and removing whatever feels like a barrier to them accessing this engineering space and the broad spectrum of their existence in the context of higher education.*

This work became the first affirmation of why I should be an engineer outside of myself and subsequently found grounding in the engineering field. My decision to be an engineer wasn't for my own kind of comfort in financial provision; there was something more here. I contribute a lot to NSBE for my foundational work in using engineering to create a greater impact on the community around me.

4.6.4 Scene V4: The Influence of General Courses on Pre-Critical Awareness and Denial Behavior

Space in Time-Undergraduate

Summary: In scene 4, Vee discussed the questioning of her decision to be an engineer due to her excitement in an anthropology course. However, she quickly put this excitement aside so she could focus on her engineering degree.

Throughout my undergraduate experience, the only time I questioned my decision to be an engineer was in my general curriculum courses. I took an anthropology class, and I absolutely loved this class and the material. I remember very distinctly that we studied folks who were addicted to cocaine. We also did another case study on a small community in Guinea. Although I couldn't personally relate to their cultural experiences, I was so drawn into the life stories of these people and inspired by how they built their lives, and the reality of their contexts. Even though I didn't have similar experiences I could always extract pieces of their stories and relate them to my own lived experience. There is something about studying people, learning from them, and being invited into their spaces that ignited a genuine love for this class.

[Pre-Critical Awareness] *This love for anthropology was never experienced when I was studying differential equations or other classes that I needed to take for my degree. I remember*

feeling so much more invigorated in environments related to social science in comparison to never feeling like this in courses like statics and dynamics or engineering economics.

Regardless of how much I wanted to focus on the technical spaces, there's something about community for me, that continues to call me to people's experiences and feel a responsibility to show up, connect people to resources or build community with them.

[Non-Critical Behavior] *On the flip side, I had to get this engineering degree, and this love for the community was interfering with the main goal of getting this engineering degree. So I just went through these social courses and said, "Ok, that was fun" and went back to the primary goal at hand.*

4.6.5 Scene V5: The Influence of Study Abroad on Denial Behavior, Critical Awareness and Behavior

Space in Time-Undergraduate

Summary: In scene V5, Vee discussed doing an independent study abroad in South Africa. Her advisor recommended only taking humanities courses and once again these courses were liberating to her. As the scene continues, she discussed her awareness of the clear inequities just from driving down the road and discussions with near peers about ways to address long histories of injustice.

In my junior year, I got really burnt out and decided I wanted to study abroad. I chose to do an independent study in South Africa because I didn't want to be stuck in this small American cohort, which, in hindsight, was the best decision.

[Non-Critical Behavior] *My advisor recommended not taking my core engineering classes there, and now I believe that was a little bit of elitism on his part. However, while there, I followed that guidance and completed my final humanities course.*

I remember taking a filming history course, which required much writing. The professor there knew that I was an engineering major, and she would say, “you don’t seem like an engineer”, and I would say, “thank you.” In the filming history course, I remember feeling invigorated by the course content and having deep reflections on the ways stories are told, who gets to tell them, and what we know from the telling of history versus how the perspective of the storyteller changes the story.

The history of Apartheid in South Africa is still so stark to me. Being in this place, I could visually see a separation that still existed. When I arrived, one of the first things we did was celebrate Nelson Mandela's birthday. Before this experience, I had heard of apartheid, but I hadn't done any deep study into it. The celebration of Nelson Mandela allowed me to become more aware of his legacy and commitment to a very vigilant fight for folks around this issue.

[Critical Awareness] I also was able to perceive the very stark contrast of separation in South Africa and was aware of access and privilege that favors White South Africans. Even driving in Cape Town, on one side of the road, there would be clearly multimillion-dollar homes facing the ocean, and then directly on the other side are these experiences of townships that belong to Black South Africans. In addition, I think during that time, they’ve had resurgences of xenophobia, similar to many other countries. If you are paying attention, it’s hard not to be aware of the social inequities present in South Africa, but people still struggled to be aware of the systems of oppression when they are right in front of them.

On campus, students talk about these things. In particular, I remember a group of Americans who were in a similar study abroad program saying things like, “I can't believe it's like this”

[Critical Behavior] *I remember responding with, “Do you know the history of your country in America?”*

[Critical Awareness] *In these moments, I came to the realization about the different ways in which South Africa versus the US have addressed these histories and start trying to move towards rebuilding and making amends, or not, in some cases.*

[Critical Behavior] *I spent a lot of time reflecting on the actions that address what has been a long-standing systemic disparity and how these actions look in different places? In addition, reflecting on who has the responsibility to address long-standing issues of systemic disparity. In the community, these were the types of conversations that came up while I was there. In a way, I've never had those types of conversations before, and I don't think in the same way I did while I was in South Africa.*

My time in South Africa was really important in my motivation to address social inequities in my engineering career. I ended up staying longer than originally planned, mainly because of my involvement in this organization. During my time there, I was working with students, and they were having a lot of teacher strikes. It felt more crucial to be in that space to kind of fill a gap in a way. Some of my fondest memories are with those kids, and it was the highlight of this trip. It was a mutual learning exchange; we'll do some math together and they'll teach me some vocabulary. I didn't do as much traveling and sightseeing as I intended, but once I connected with the group, I felt most comfortable in this space.

4.6.6 Scene V6: The Influence of Humanitarian Efforts on Pre-Critical Consequence

Space in Time-Undergraduate

Summary: In scene V6, Vee discussed emerging herself in the community in South Africa and with an empathetic lens notices how humanitarian groups failed to ask essential

questions. Witnessing these efforts made an impact on her desire for a career that impacted her quality of life.

Through this network, I did a short internship with an engineering company. Since I went on my own, I was more open to making connections with people who lived there and got access to this opportunity by serendipity. I saw life in the townships, specifically their water and sanitation.

[Pre-Critical Consequence] *By being with the local folks, I also witnessed projects that were done by humanitarian groups or church groups who were well-meaning but were not serving the communities in a compatible way. From the local perspective, they never asked, “is it good for these people specifically?” or “does it integrate into their lives and their values?” For this very reason, I went to grad school because I wanted to be in the Peace Corps, and I wanted to know more things about this space before joining. I didn’t want just to be someone straight out of school thinking I was helping people, but I was actually making things worst.*

I made a direct connection to my career, and it was the first time I decided not just to do environmental engineering, but to do into my specific discipline of water and wastewater because this part is integral to the quality of life. It was my desire to be in the Peace Corps to just focus on that type of work.

4.6.7 Scene V7: The Influence of Black Murders on Critical Awareness and Behavior

Space in Time-Undergraduate

Summary: In scene V7, Vee discussed coming back from South Africa and being confronted with the murder of Trayvon Martin. Around the same time, NSBE was having a national convention and the members decided to stand in solidarity. Vee considered this her first time recognizing the privilege she held and her connection to a larger social happening.

[Critical Awareness] *When I returned to America, I faced the reality that white supremacy was aggressive, and I perceived white spaces as less safe.*

This was a time around the killing of Trayvon Martin, and NSBE was having its national convention. The convention is a mass gathering of engineers in training, and professionals and executives at all levels. We were supposed to be in our best business attire for the 4 days of the convention, and I remember the communications around us wearing our hoodies throughout that time. It was just a stark image because everyone wore their suits with their hoodies under their blazers.

[Critical Awareness] *I think that was the first moment where I saw the connection to a larger social happening and what it said to me to be folks who are considered quote-unquote “elite Black folks” who are in in the world being changemakers and geniuses when at first glance wouldn’t even be considered engineers if we didn’t say it.*

[Critical Behavior] *We were all standing in this place of privilege and still holding ground to make the statement that, “we are Black in a way that he is Black, and we have struggled in the ways he has struggled, and we could easily be victimized and the way that he was.”*

We can never forget and let these murders be diminished, because of whiteness’ wrong perception of who Black people are in this larger picture. This was a pivotal moment for not only NSBE but for me personally because I remember taking that into grad school with me. I remember also being the first inching toward a louder voice when it came to social justice issues.

4.6.8 Scene V8: The Influence of PWI on Critical Consequence and Behavior

Space in Time-Graduate School

Summary: In scene V8, Vee discussed the continuation of Black murders and their influence on the white environments she was placed. The silence surrounding Black Lives Matter made her angry and pushed her to no longer be comfortable not doing anything. As a result, she went to the university's culture center to engage with critical Black resources.

Going into grad school, I felt like we entered this barrage of Black folks being killed by the police. I went to grad school at [a PWI], another whitespace like my undergraduate institution.

[Critical Consequence] *The climate felt more aggressive, or more overt with its white supremacy due to people's silence and complicity around the issue. I felt like I was expected to go in and do the work unfazed while, on the other hand, hearing commentary denigrating this boy who was killed for just being a boy in a place someone thought he didn't belong. The way folks reacted to that and turned a blind eye led to the perception that white spaces are not safe the way I initially thought they were. In the workspace, it feels like you have to bottle up your anger, but it's still there. I had to find a way to process what was happening to Black bodies and turn the personal rage that eats at you into something that can be more empowering. I can trace this to the motivation to go to grad school and to the work I'm doing now.*

[Critical Behavior] *Following Eric Garner, it became harder to just focus on my degree, and do the volunteer things on the side, it became more like I had to speak to Black violence directly. I started going to the African American Cultural Center, which had its own library. I love to read and I ended up spending a good deal of time in the center learning and growing. The library featured Black authors, Black thinkers, poets, and art. It was an empowered place to reteach history, question your own thinking and engage with critical dialogue around Black thinkers.*

4.6.9 Scene V9: The Impact of Liberation on Critical Behavior

Space in Time-Graduate School

Summary: In scene V9, Vee discussed the internal work of relearning history and being comfortable with the way she expressed her Blackness. Following Michael Brown’s murder, she connected with Black peers and organized a protest. Following the protest, they developed a narrative project to keep the momentum up and clarify why a protest was necessary.

In this relearning, I started to change the way I presented myself. As opposed to trying to be the most palatable version of myself in white spaces, I got a little militant.

[Critical Behavior] *I began to own and express my Blackness and focus on my internal work. I started to dismantle respectability politics. Even in my work now, I have to constantly challenge the ideas around white supremacy.*

As my involvement with the African American Cultural Center increased, I got plugged into the larger Black community at the university. There were two women in particular, both getting their Ph.D., that I found myself in dialogue. We were lamenting about some things we heard on campus around the time Michael Brown was killed.

[Critical Behavior] *In collaboration with the Cultural Center and the Black Student Union, we helped organize the first protest I'd ever been a part of. We marched and chanted from the cultural center to the main library and laid down for the duration of time that he lay in a street. I never considered myself an activist, but at that moment, you couldn't tell me, I wasn't. As we lay there, some people complained about the inconvenience, and there were a few folks that joined us. After time passed, we got up and marched back.*

Conversations after were like, “Ok, so what do we do now?” I remember that after the protest, people were still so confused about why we had to do that and believed that it wasn't

necessary. We aimed our planning for the campus by making the connection of being Black at [PWI Institution] correlated to how it probably felt to be Black in Ferguson.

[Critical Behavior] *In response, I started to develop this narrative project where students of color at the university have a chance to say what's happening for Black folks in the quote-unquote, "Happy [Place]".*

In graduate school, we were in the space of building a team that would like to help us support the narrative project. Somehow, we got enough attention that we were invited to meet the Chancellor and go to this dinner but it was very performative. As I reflect, it was not like he wanted to do something about the issues we were having with the university. This work became more important than the engineering piece and it felt like something I did outside of engineering. We hit some road bumps as we started to collect these narrative stories, and it was ongoing after I left because I was there for a short time.

4.6.10 Scene V10: The Influence of Graduate School on Non-Critical Behavior

Space in Time-Graduate School

Summary: In scene V10, Vee discussed the challenges of her graduate program. She was motivated to make a difference in wastewater management but along the way became discouraged and disconnected from her work for multiple reasons. This resulted in her being mentally drained and losing her passion for engineering as she persisted to the finish line.

At this point, I am working toward my Master's, and everything about that is just not going well. I went into my Master's study wanting to make a difference in wastewater management. I was drawn to my advisor's work because she operated a pilot sketching plant that used plants for remediating and treating wastewater. In my mind, if you're in a place where the technology of treatment is not readily available, then being able to harness the power of the

natural environment to do the work of creating clean water and sanitation seemed accessible. I think she knew what she wanted to do and she saw how I could fold into that. However, she didn't necessarily see how I could expand this work into something that was more meaningful to me. At the time, I didn't have the language to express my needs clearly and I started to just detach a little bit.

I doubted every decision I made in my commitment to grad school, except in the moments when we were working on the narrative project. At the university, there was a heaviness around being Black on that campus, and the environment was physically and figuratively cold. In addition, the logistics of graduate life were not great. My advisor started to turn sour on me because of a planning issue, and I started to focus on getting out of there. Overall, I was mentally and emotionally drained.

[Non-Critical Behavior] *At the time, I was starting to realize I would need to have more passion for the engineering field than what I had to give. I questioned why I didn't have that passion but quickly stuffed that down because I had come too far not to cross the finish line.*

4.6.11 Scene V11: The Influence of Survival on Pre-Critical Awareness

Space in Time-Workforce

Summary: In scene V11, Vee discussed focusing on her family and paying off debt due to the ways things with her advisor ended. At this time she needed to focus on stability so she returned to an engineering environmental consulting firm. Her psychological need for safety had to be established before she could take the risk of doing social justice work in engineering.

After I left grad school, I fell in love and wanted to focus on nurturing my relationship, so decided to put my desire to go to the Peace Corps on the back burner. I came out of grad school with more debt than I should have, because of how things ended with my advisor, and my need

for stability was at the forefront of my mind. I felt like I needed some ease after grad school due to being emotionally drained, and my well-being needed to be regained after that time.

I returned to an Environmental Consulting Firm, where I interned during undergrad, for multiple reasons that contributed to the comfort I needed at the time. I still played a role in protecting waterways and in kind of ensuring the compliance of the EAS industries. I was working with private sector clients and felt really far from the work I would have been doing with the Peace Corps. The important thing was that I didn't have to shrink here and unlearn my own space of self-empowerment that I came into the workforce with.

[Pre-Critical Awareness] I needed to feel some sense of safety and security to reach into the more extensive social justice work. A sense of security was the foundation of my hierarchy of needs and was necessary to engage in the risk of doing social justice work. Otherwise, the perception of risk surrounding social justice work seems too great. In these moments of working in the consulting firm, I felt like I let folks down or sold out my values because there was a low connection between engineering and social justice. However, in processing through therapy, I learned that in these moments, I was trying to survive and had every right to practice this self-care. While focusing on my career and family, I was piecing myself back together by finding joy, safety, fulfillment, and overall peace.

4.6.12 Scene V12: The Influence of Restoration on Pre-Critical Consequence and Critical Behavior

Space in Time-Workforce

Summary: In scene V12, Vee discussed finding the safety and being able to take the risk to do equity and social justice work. She received her PE which provided more confidence in her ability to integrate social justice into her engineering work. Once the pandemic happen and she

became a mother, she had a strong desire to align her personal values with her engineering work. She concludes with a reflection on liberation in engineering work and legacy that she wants to leave behind when she is gone.

Finding safety to take the risk of equity and justice work took a really long time [5 years], but I was still able to take on diversity projects in the workplace, mentor young individuals interested in STEM and acquire the necessary credentials. An important milestone was receiving my PE, which helped established some credibility to make a full-time shift into justice-related work.

[Pre-Critical Consequence] Until I reached the experience marker, I understood people would disregard what I could bring up in terms of environmental justice and social equity in engineering practice due to observations throughout my career. Not speaking on the group overall, but in my observance of engineers, we can be kind of elitist. I knew if I had that credential, I would be able to address the comments surrounding why they should listen to this woman talk about this subject. I also wanted the credential to prove to myself that I could do engineering work and that I was a real engineer.

After having the space to recover, I think a new foundation has been laid for personal wellness and risk-taking. I owe a lot to those quiet years of putting myself together and accepting kind of the security of my family unit. In 2020, a catalyst for centering engineering work on equity and justice was the birth of my daughter and the pandemic. In undoing myself, I want to mother from a place where I can offer her liberation.

[Critical Behavior] To prepare for motherhood, I needed to reevaluate my values, and I came to the conclusion that my engineering work has to be different. I couldn't teach someone to be brave by living their values without doing it myself. I questioned my motivations and fears

that were driving my decisions and then started figuring out a path out of fear-based decision-making towards value living. Through this, I got to the work of infusing justice and equity in my engineering work.

In my role now as an environmental justice policy advisor, people even respond differently to the office than they did before. I've heard comments like "they have an engineer here now" and "we can really do some work together now". These comments show how clicky the engineering field can be and how challenging it can be to get a group of engineers to listen to have to say.

[Critical Behavior] *For instance, when we're talking about engaging with the public that is predominantly Black or wage workers, the organizers talk negatively about these people not showing up. Having to deconstruct this myself, I ask if they ever considered the history that these folks are living in. The communities have this generational knowledge of government coming in, making promises, and not doing anything or completely running over them. Let's not say they don't care and own that, as an agency, we have some trust and relationship-building work to do on our part.*

The work of addressing systematic oppression is deeply personal, and I can see its value in teams when you have to drop your preconceived notions and stereotypes that you're bringing into this room so that we can create an atmosphere where folks are empowered to help us make decisions that are going to impact their lives on this land. My personal liberation benefits the way I can show up in these engineering spaces and challenge some of the things that maybe no one would have challenged before.

If there's a little battery charging with 100% at liberation, maybe I'm at 60%. However, I know that liberation is the goal. Liberation to me means more fearlessness to do what it takes to

always be introspective and trace the roots of influences and determine if you will continue to allow them to influence you. In addition, owning up both audibly and visibly that systems of oppression are a part of my narrative, there's no shame attached to it. In the end, I want to be proud of myself and not in the sense of accolades and achievements but knowing that I took up the time and space that I have here on Earth to make people, places, and things better. Better as in more welcoming and more like home where you could just know that you're cared for, and the spaces reflect that. Being proud of myself in the work I do feel like a legacy work leaving.

4.7 Summary of Results

This chapter presents the five career journeys of Black engineers inspired to incorporate social justice in the engineering practice. Each narrator provides an in-depth description of the multiple incidents within their childhood, education and careers that influence their awareness, behavior, and perception of consequences. The levels of SPD along each narrator's career journey is provided in Figures 9-13 to illustrate the pathways through SDP along their engineering career journey. The SPD levels and domains will be discussed in greater detail in Chapter 5.

5. Chapter 5: SPD Elements and Pathways Across Narratives (RQ2)

5.1 Introduction

This multiple-case narrative study explored the manifestation of pathways through sociopolitical development (SPD) among Black engineers. In Chapter 5, I will answer research question 2: *How do SPD elements manifest in the career narratives?* This question has the following sub-questions:

RQ2a: How do SPD domains and levels appear in the career narratives?

RQ2b: How do narrators move through the SPD elements throughout their careers?

Section 5.2 will first provide an in-depth analysis of the narratives by identifying the domains and levels of SPD that manifested along these Black engineers' career journeys (RQ2a). Then section 5.2.1 will present the results in each domain: *awareness*, *behavioral-response*, and *consequence*. Following, section 5.2.2 will present the results in each level: *non-critical*, *pre-critical*, and *critical*. After, section 5.2.3 will discuss the prevalence of domains within each level. Next, section 5.3 will provide a high-level analysis of the narrators' SPD development along their career journey to describe their multiple pathways through an SPD process (RQ2b). In conclusion, chapter 5 will discuss how SPD elements manifest in the career narratives.

5.2 SPD Domains within Black Engineers' Career Journeys (RQ2a)

The second research question identified the SPD domains and levels within each narrative. This section will describe the trends I identified within each domain (*awareness*, *behavior-response*, and *consequence*), combining the five career journeys. Across the domains, the *consequence* domain was the most prevalent SPD element present in the narratives. These topics surround racial/gender discrimination, internalized oppression, isolation, engineering

systems, personal well-being, and responsibility. The second most prevalent SPD element is the *behavior-response* domain, where narrators reflect on their participation in Black culture, developing strategies for navigating injustices, questioning knowledge, changing work environments, integrating new perspectives, suppressing emotions, and doing nothing in response to various situations along their career journey. The least prevalent SPD domain is *awareness*, which includes the role of awareness of self, utility of actions, social-technical divide, social inequities within communities, inequities existence, and utility of actions. In this section, trends across, *consequence* (Section 5.2.1), *behavior-response* (Section 5.2.2), and *awareness* (Section 5.2.3) will be discussed.

5.2.1 Consequence Trends

Consequence describes a temporal aspect that helps reveal cause-and-effect relationships between social forces and social circumstances and the believed effect of inequities. The *consequence* domain is noted when the presence or lack of consideration of past, present, or potential events and their outcomes are attributed to a system or social factors that shape the lives of people or the identified problem. When narrators discuss being actively involved in the process that led to a conclusion, this component of the narrative was considered a *consequence*. Through my analysis, I considered this to be distinctively different from the awareness domain, where narrators noted the passive thoughts that came to the narrator's attention. Within the *consequence* domain, the narrators discuss actively processing experiences surrounding racial/gender discrimination, internalized oppression, isolation, engineering systems, personal well-being, and responsibility.

5.2.1.1 Overt Racial and Gender Discrimination

Overt racial and gender discrimination made the narrators aware of social inequities along their career journey. Narrators attribute their experience with discrimination to their existence in predominantly white male environments. For example, before going to college, Khalil describes his complete acceptance of his Blackness in growing his hair. However, once he decided to go to PWI, his high critical consciousness increased his awareness of institutional oppression. Prior to entering his engineering discipline, he experienced being bullied for being Black during his childhood. Therefore, the potential of experiencing overt discrimination for expressing Blackness led to his decision to cut his hair to be successful:

I never considered myself someone who incorporated social justice into engineering. Before I enrolled in engineering I knew colonization, capitalism, and racial discrimination existed. Knowing that these systems existed, I cut my hair; not because I wanted to cut it, but because I felt like I had to cut it. I knew I was going to this PWI and I was trying to secure internships. I cut it by simply trying to assimilate in ways I didn't want to, but I felt like I had to. (K5)

He later explained that despite having a competitive GPA, he and his Black peers were never able to secure internships while white peers with lower GPAs were offered job opportunities each year.

Similarly, Penguin experienced overt gender discrimination in her engineering classroom in the pre-college space while being on a team with three girls stating:

For my immediate team, all three of us were ladies. In this class, the gender differences were way more apparent given that the class was majority boys, and the three girls were all on one team together. There definitely was a lot of gender bias at play with other male

students in the class saying things like, “three girls can't build a nice sturdy bookshelf for this elementary school.”

I got a bit heated in class because we spent three months working on this whole project from start to finish. We were day in and day out, putting in work, working alongside our classmates, and people are making snarky comments about us the entire time.

It was a bit challenging to deal with the comments, but at the same time, we had support and camaraderie within our internal team, and we persevered through it all. My mom also encouraged me not to let snarky comments dissuade me from pursuing my interest or my goals. I felt supported in doing engineering by my mom and family and continued on the engineering path despite the bullying.

Unfortunately, this bullying came up in other avenues. In the classroom, people were saying that certain people are getting opportunities only because of affirmative action..... I have all these experiences in my past to look back on that relate to inequity or injustice and I am aware that it is a thing. I learned how to navigate people who have different personalities and different motives. (P3)

In this scene, Penguin turns her experience with discrimination into a story of resilience and perseverance. Her resilience came from her personal self-esteem, peers, and family support structures. These support structures enabled her to not internalize discrimination and utilize critical consciousness to be aware of injustices.

It is considered overt discrimination when an individual or group openly and intentionally discriminates against people of a particular race or ethnicity. This can take the form of using slurs, denying opportunities or access based on race, or engaging in hate speech or violence.

Overt racism is often explicit, visible, and easy to identify. The opposite of overt discrimination is covert discrimination, which will be explained in the next section.

5.2.1.2 Isolation in Predominantly White Spaces

The isolation category is separated from the discrimination category because isolation is a function of covert oppression, as opposed to the overt discrimination that narrators experience. Covert oppression is often subtle and difficult to recognize. In predominantly white environments, being a high-achieving Black person can sometimes come with isolation from people who look like you. However, this isolation is a byproduct of structural oppression, built within standardized testing, policies, and practices. An example of isolation is described in Vee's narrative of her navigation through high-achieving programs and courses, stating:

I initially believed I was placed in “special and talented” environments due to my own efforts. Over time, you start to see those spaces don't necessarily reflect an even split of the overall school. In this exclusive space, I became the minority in that way. As I got into the honors and AP courses, I found myself again in a group that didn't match the demographics of the overall school.

At the time, I didn't have the words or research I have now, but I could still feel like it didn't make sense. I now know these spaces were skewed toward whiteness. I knew those kids outside of honors and AP courses because they lived in my neighborhood. I would hear teachers talk negatively about other students that weren't considered “talented and gifted,” and I knew they were smart. I always felt the wrongness/achiness about it, and I took this feeling with me as I searched for safe spaces in my engineering undergraduate experience. (V2)

Programs that display segregation without overt discrimination can perplex an individual in understanding the issue's root. Similarly, Richard described his isolation in his undergraduate career stating:

The biggest challenge is the cultural environment of going to a predominantly white institution and being the only one in many cases. On top of this, the majority of my teachers were white males. Whether within the seminar class or in the engineering classroom, I found myself always dealing with those dynamics. I attended an all-minority school until high school, so college was my first exposure to a more diverse environment. Through this culture shock, there were moments when I became more aware of the duality of who I am, how I look, and how people perceive me. I had friends who were not minorities, and develop strong relationships, but there were moments when I realized I would never be as close to them as their white counterparts just because of their life experiences alone. Even from the outside in, I noticed how they would interact with each other versus how they would interact with me. Some of this could be all perception and not necessarily real but I have these moments all the time. (R3)

Unfortunately, Richard could only theorize why he was isolated in the predominantly white environment and described it as culture shock because this was his first encounter with whiteness. Programs that limit access can perpetuate inequality and inadvertently reinforce racial and socioeconomic stereotypes by not intentionally discriminating. These racial and socioeconomic stereotypes can lead to internalized oppression.

5.2.1.3 Internalized Oppression

Internalized oppression refers to how members of marginalized groups come to accept and believe in the negative stereotypes and beliefs that society holds about them. According to

Jemal (2016), transformative consciousness is essential to understanding how and in what ways individuals have internalized oppression and been impacted by structural oppression. Nina provides an example of internalized oppression when she discusses her experience in an inner-city school and being grouped with underachievers:

The high school I attended was an inner-city high school that was underperforming. It was the opposite of a creme de la creme and more so a place where you get your degree in a graduating class of 100. Maybe out of that 100, two people will graduate with a bachelor's and the majority of them had kids within the first two years and did not make it past that hurdle. (N2)

As she continues narrating multiple instances along her journey, the internalized oppression became more apparent as she perpetuates negative stereotypes about racial groups and the need to distance herself from others who share her identity. Internalized oppression can have a range of negative impacts on individuals, including lowered self-esteem, diminished sense of identity, and internalized feelings of shame and self-hatred.

5.2.1.4 Sense of Responsibility

Narrators discussed their agency and responsibility to engage with communities. For described the sense of responsibility to be a part of something bigger than herself as child stating:

As I think back, even at this age, my interest was captured by the link to the environment, something that felt more tangible, something that felt like I was still connecting with people. But as I've been reflecting, I think there is still this kernel of doing something that improves the environment and is much bigger than yourself. I'm still contributing to something that's overwhelming and simultaneously yields financial stability, which may be what my life at that point had no experience with. However, I needed to take care of

myself and be a part of something broader than myself. A combination of the positive reinforcement and perception of a career in engineering from my environment led to my decision to pursue an engineering career. (VI)

In scene 1, she reflects on what it means to her to pursue a career linked to the environment and the constant positive reinforcement of pursuing an engineering degree. This sense of responsibility is consistent as the narrators progress through their careers. For instance, Penguin discusses being in the industry for 10 plus years and still has reflections on her responsibilities as a Black women engineer stating:

As I reflect on my personal path to becoming an engineer, I remember that I entered this field to help people. This motivation comes full circle when engaged with projects that provide a direct benefit to vulnerable populations. As a Black woman who has made it to become a civil engineer and done pretty well, bringing an equity lens to the work that I do is a responsibility moving forward. (P9)

As Penguin navigates her career journey, her motivation to help people is there at the start of the journey and it carries her as she finds avenues to engage. In both scenarios, narrators discuss their interest in engineering to be a part of helping communities and how this motivation enables them to bring their critical consciousness to the engineering work environment.

5.2.3.5 Engineering Systems

Narrators made specific evaluations of engineering education, engineering practice, and engineering values as they narrated their career journey. I will provide an example of each component of engineering systems the narrator offers. I will start with Penguin's experience of being in Japan to study abroad and noticing the differences in education in Japan versus schooling in America:

Before my time in Japan, the separation between people and technology was largely due to how engineering was framed in an academic context in America. When studying engineering, you're solving technical problems and the technical consequence is the only thing that matters. The technical perspective is a very narrow kind of lens. The nature of these problems were not cut and dry as my American professors presented them. (P5)

In scene 5 of Penguin's narrative, she was able to identify the root issue of the technical and social divide in the way engineering is taught in America. She identifies the consequence of a limiting engineering profession due to the narrow focus on technology and how this is the result of Americanized education.

On the contrary, Nina evaluated engineering practices by comparing her work experience as a psychologist versus the contributions her work experience will make in the engineering field:

As a psychologist, I felt I was making a difference by reuniting families and dealing with substance abuse. With engineering, I felt like I was lining some white guys' pockets more than I am making a difference. (N6)

In scene 6, Nina discusses her perception of the impact that psychologist make in comparison to engineering. She evaluates this consequence because she could witness the impact of therapy in reuniting families. However, when evaluating engineering outputs she identified the consequence of people getting richer as the true impact of her engineering work.

Lastly, Vee evaluated engineering values by the ways they treat people without engineering degrees, discussing equity challenges versus the shift in values when working with someone with an engineering background:

Until I reached the experience marker, I understood people would disregard what I could bring up in terms of environmental justice and social equity in engineering practice due to observations throughout my career. Not speaking on the group overall, but in my observance of engineers, we can be kind of elitist. I knew if I had that credential, I would be able to address the comments surrounding why they should listen to this woman talk about this subject. I also wanted the credential to prove to myself that I could do engineering work and that I was a real engineer. (V12)

For Vee, earning an engineering degree was not enough to prove her credentials and credibility in incorporating social justice in engineering practice. Within engineering practice, she felt the need to earn the highest credential in engineering practice in order to be worthy of meaningful contributions to the field. Overall, the consequence of the narrators' perceptions of engineering systems reveal the shared ideas, priorities, and values within engineering environments.

Next, I will discuss the trends in the behavior domain.

5.2.2 Behavior Trends

Behavior refers to consciousness surrounding potential actions that could challenge inequities within environments. Behavior is noted when narrators mention the presence or lack of reactions (both action and verbal) that either blame individuals or respond to the individual and social forces that shape people's lives or the identified problem. A reaction can refer to a person's emotional or behavioral response to a particular event or situation.

Within the behavior domain, narrators discuss the necessary actions in response to the shape of people's lives or various identified situations that appear across the career journeys that, including participating in Black culture, developing strategies, questioning knowledge, orienting

authenticity, integrating new perspectives, suppressing emotions, and doing nothing in response to various situations along their career journeys.

5.2.2.1 Navigating Injustices

Within this category, narrators reacted to personal experiences they considered unjust. For example, in Nina's narrative, she described her institution as a place with racial separation regarding the distribution of resources. In her perception of lack of resources, she explain her ability to address the injustice by being friendly and kind to people to gain access to help she would have otherwise been excluded from:

I've made it a point to be friendly to everybody, because there would be times when people would share tests. Mind you, because I was a Black student, I didn't have any versions of this test because there weren't a lot of Black students in civil. I networked with everybody because I knew I would get access to all of the stuff I needed to be successful. (N3)

On the other end, when Vee needed to address silence in her communities on the senseless murders of Black people, she placed a spotlight on the experiences of Black students within her environment through a narrative project:

I started to develop this narrative project where students of color at the university have a chance to say what's happening for Black folks in the quote-unquote, "Happy [Place]" (V9)

These are both vastly different ways of addressing exclusion whereas Nina leaned on networking and Vee created an outlet for the community to express their concerns within academia.

However, as with participating in Black culture, there is not one way to navigate injustices.

Instead, there is space to work within and throughout systems of injustice when addressing

support needs. Within the navigation of unfairness, I noted that these strategies didn't necessarily consider long-term system-level change; however, they are short-term solutions that allowed them to take up space in an environment they felt they didn't belong.

5.2.2.2 Participating in Black Culture

Participation in Black culture looks different across these narratives. For instance, Khalil discussed his participation in Black culture when his behavior shifted around actions demonstrating confidence and acceptance of his cultural identity. This included growing his hair out, engaging with Black media, and overall social interactions when stating:

I started growing my hair out and having different styles like cornrows. I found myself practicing aspects of culture that I haven't before including entertainment or sports or social interactions... I began not to be defensive about my Blackness and more accepting of who I am and have always been. At this age in my life, I am continuously becoming more comfortable, more affirmed, more proud, more open, and more willing to express racial and cultural aspects of myself openly. (K4)

Whereas, Vee described her participation in Black culture as relearning history, engaging with content from Black authors, and being present in Black spaces like the Black cultural center:

I began to own and express my Blackness and focus on my internal work. I started to dismantle respectability politics. Even in my work now, I have to constantly challenge the ideas around white supremacy. (V9)

There is no correct or wrong way to engage in Black culture, and through this analysis, I considered these behaviors critical to their sociopolitical development. By participating in Black culture, the narrators find their sense of belonging, empowerment, and self-acceptance as they navigate engineering careers.

5.2.2.3 Orienting Authenticity

As narrators discussed the behavior of aligning careers, values, ideologies, and perspectives with their motivations and interest to incorporate social analysis within engineering, I have coined this term as orienting authenticity. Vee addressed the need to find safety and security before aligning her career with her core values:

To prepare for motherhood, I needed to reevaluate my values, and I came to the conclusion that my engineering work has to be different. I couldn't teach someone to be brave by living their values without doing it myself. I questioned my motivations and fears that were driving my decisions, and then started figuring out a path out of fear-based decision-making towards value living. Through this, I got to the work of infusing justice and equity in my engineering work. (V12)

The catalyst for this alignment was coming into motherhood, and she wanted to be a positive example for her child. Going from one space to another can be ground shattering but looking back, the narrators describe the need to align critical behavior with critical perspectives.

Richard also described the need to orient authenticity as he transitioned into a professional role stating:

From the new awareness, I grew in understanding of the role I need to play as a professional. I adopted the view that it is my responsibility to help and support other minority engineers along the way. (R8)

In scene 8, Richard identified his sense of responsibility as a Black professional and the behavior of support that was vital for other minority engineers he came in contact with. This finding demonstrates critical motivations to engage in action.

5.2.2.4 Questioning Knowledge

There are instances where the narrators provide examples of questions they engage with during their sociopolitical development. For example, Vee and Richard described themselves as questioning the world around them. In Scene 5, Vee describes herself reflecting on actions of injustice and who is responsible for addressing them:

I spent a lot of time reflecting on the actions that address what has been a long-standing systemic disparity and how these actions look in different places. In addition, reflecting on who has the responsibility to address long-standing issues of systemic disparity. In the community, these were the types of conversations that came up while I was there. In a way, I've never had those types of conversations before, and I don't think in the same way I did while I was in South Africa. (V5)

Determining the responsibility to address long-standing issues is complex and solely depends on the problem that is under analysis.

On the other hand, Richard questioned who the authors of his textbook were and were able to point out that they were all white when stating:

I even analyzed my textbooks and noticed the white authors' backgrounds. When it came to perceiving certain things in engineering, I knew it was from that author's lens. (R2)

In both instances, the narrators are combating the normative narrative of spaces by interrogating their existence. Whether through dialogue or personal reflections, these narrators questioned the existence of structures, narratives, and identities in order to make sense of present circumstances.

5.2.4.5 Suppressing Emotions

The narrators discussed their indifference towards engineering work but felt the need to suppress the apathy to persist in engineering environments. This experience relates to stages in

transformative consciousness development when an individual attempts to find ways to hold countering beliefs while struggling to maintain pre-existing beliefs in the face of contradicting information or experience. An example of this is depicted in Penguin's narrative after she witnessed community organizers address social inequities in what she perceived as non-conventional:

Most of my collegiate academic experience had been so heavily focused on the technical aspects, and I realized that my interests were more on the non-technical aspects. I remember feeling really conflicted because I spent all this time and effort on engineering, and it isn't actually what I want to do. Despite the conflict, I continued to work through my courses and started applying for just regular engineering jobs. Since I did all this work, doing nothing was not an option. (P8)

In this timeframe, she was holding two countering ideas; however, she could suppress the feelings of changing trajectory by persisting through this duality. Similarly, Vee discussed her invigorated passion for studying people and how it was best to suppress the feelings of her love for the community in order to persist stating:

On the flip side, I had to get this engineering degree, and this love for the community was interfering with the main goal of getting this engineering degree. So I just went through these social courses and said, "Ok, that was fun" and went back to the primary goal at hand. (V4)

In both examples, the narrators are reflecting on their engineering identity after they engage in community efforts. This finding points to ways integrating community engagement in engineering could increase persistence and engineering identity.

5.2.4.6 Conscious Inaction

I identified the absence of a reaction as doing nothing. Doing nothing could also be considered “non-action” or “inaction.” An example of this behavior is illustrated in Scene 4 of Nina’s narrative, where she discusses her reaction to her perception of an unfair funding system: *“In regards to this larger funding issue, I didn’t advocate for myself and took the passive approach that this is the system I’m in and let it go.”* (N4) Nina expressed the need to get through the engineering discipline as intact as possible. There are certain circumstances where challenging an unfair system will cause more damage than add benefits to the individual.

In scene 9, Penguin also discusses the cost-benefit analysis of providing an equity lens in her company and concluded that things will not change whether she brings in an equity lens or not stating:

When I first came into this particular company, I wasn't intentionally bringing equity considerations to the work that I did. However, I think I've found opportunities to incorporate them throughout the years. Frankly, it's not as intentional as I would desire it to be, but I view it as playing the long game. (P9)

In this example, doing nothing is perceived as “playing the long game” which refers to a long-term strategy or endeavor to preserve energy so that when she does provide an equity lens it makes the desired impact. Within engineering environments where equity is not a value, doing nothing is either the best or only option.

Next, I will discuss the *consequence* trends identified with the narratives.

5.2.3 Awareness Trends

In my study, awareness reflects recognition of the underlying causal factors or potential solutions to the situation under analysis. Awareness is noted when narrators mention the

presence or lack of consideration of thoughts and insight about individual and social forces that either blame individuals or contribute to the shape of people's lives of the identified problem. Within the awareness domain, the narrators discuss the role of awareness of self (self-awareness), the utility of actions (awareness of engineering utility), the social-technical divide (awareness of the social-technical divide in engineering environments), and social inequities within communities (awareness of social Inequities within communities). Each theme will be discussed below, including examples from the narrators.

5.2.3.1 Self-awareness

As narrators described their journeys to incorporate social justice, they discussed their awareness or lack of awareness of their identity or sociopolitical circumstances in connection to a larger social happening. Many narrators describe themselves as becoming aware of their injustices either by personal or secondhand experiences. For example, Khalil describes his awareness of his placement within systems of oppression as infused in his upbringing. He says:

The experiences that influenced my parent's perspective exposed me to systems of oppression and were also integrated into the framework in which they raised me. In addition, I have also had my personal experience with different injustices being exposed either directly or indirectly through experiences that my friends and family have had. For example, my parents and I lived in affordable housing, and I reflect on this as I engage with communities of low income. (K1)

Due to his upbringing, he discussed his keen awareness of his identity and how he could be potentially treated because of it. There were also narrators that describe themselves as becoming aware of Blackness and how it was essential to navigating spaces. For instance, Richard described his lack of awareness of his placement within systems of oppression when he stated:

Growing up in Brooklyn, I did not see myself as a low-income, first-generation American. In terms of Blackness, there's a different perspective on what it means as an Afro-Caribbean. I was raised in a culture where Blackness wasn't necessarily something to be taught. My Blackness was something that was there that I acknowledged and respected, but it wasn't framed in the context of whiteness. Of course, whiteness is there given by the Queen of England, but it's a little different. I was surrounded by Black people until I went to high school. (R1)

Richard became more aware of his “Blackness” as he navigated academia in a predominantly white environment. In both cases, the narrators described their level of awareness surrounding social forces and identity that shaped their navigation through their career journeys. These scenarios described the influence of parents and home environments on the ways Black engineers develop critical consciousness.

5.2.3.2 Awareness of Work Utility

As narrators discussed their career journey, they describe how their awareness was impacted by witnessing a role model making a desired impact in their work. Before describing these events, they mentioned their desire to be more involved in communities and motivated by role models, which showed it was possible. In the context of Vee's narrative, she describes the awareness of engineering positively impacting communities:

I was attracted to the sustainability and positive impact the guest speaker said he made on the community. In addition, I excelled in math and science. At the time, people heard engineering and said it would be a stable future for me, and I would be able to provide for myself financially. (V1)

In this situation, she described the recruitment techniques that increase broadening participation in STEM.

In contrast, Penguin discussed becoming aware of non-traditional methods to address inequities:

It seemed pretty wild to me that they were doing this unconventional farming that probably could have been illegal, but they didn't care. They saw the broader need for serving the community and just did it. (P7)

In both cases, the narrators described witnessing work making a positive impact on society for the first time. These scenarios emphasize the need to expose prospective students to as many pathways as possible because otherwise, they would not know these pathways existed.

5.2.3.3 Awareness of the Social-Technical Divide in Engineering Environments

As narrators navigated their engineering environments, they described their awareness or lack of awareness of the separation between social and technical spaces in engineering environments and its influence on their passion and analysis of circumstances. For example, Vee discussed being aware of her love for social science. However, she felt the need to put that to the side to pursue her engineering degree:

This love for anthropology was never experienced when I was studying differential equations or other classes that I needed to take for my degree. I remember feeling so much more invigorated in environments related to social science in comparison to never feeling like this in courses like statics and dynamics or engineering economics. (V4)

In this quote, she describes the feelings of apathy in required engineering courses compared to the passion experiences in social science courses.

Conversely, Penguin became aware of social inequities through a study abroad program in Japan. She described herself as always knowing that the social-technical divide existed but knowing that it did not make sense:

When I was in college, it was more of a separation between people's problems and technical problems, which don't really overlap. Especially if you are dealing with institutions, whether it's government or universities. I don't really know how I previously made that separation or when the separation started to break down, but I think it's a little more intertwined in my head now than it was before. (P4)

Penguin discusses the subtle emphasis on a social-technical division when dealing with institutions and the difficulty of tracing where this assumption was accepted. Although social analysis was separated from their engineering training, they were still aware of the need for social analysis. As both narrators continued on their journey, they became more aware of the intertwined nature of social and technical spaces and resisted the barriers of social-technical dualism.

5.2.3.4 Awareness of Social Inequities within Communities

Lastly, through either study abroad programs, research, or dialogue with peers, the narrators described becoming aware or lacking awareness of social inequities across different communities. For instance, Khalil discussed learning about how cultural, racial, economic, and geopolitical contexts exist through research with communities (K7). Whereas Vee participated in a study abroad program where she went to South Africa and witnessed the presence of social inequities within the environment. While being in South Africa, she described becoming aware of the realities of people who lived in South Africa:

I also was able to perceive the very stark contrast of separation in South Africa and was aware of access and privilege that favors white South Africans. Even driving in Cape Town, on one side of the road, there would be clearly multimillion-dollar homes facing the ocean, and then directly on the other side are these experiences of townships that belong to Black South Africans. In addition, I think during that time, they've had resurgences of xenophobia, similar to many other countries. If you are paying attention, it's hard not to be aware of the social inequities present in South Africa but people still struggled to be aware of the systems of oppression when they are right in front of them.

(V5)

In scene 5, Vee describes becoming aware of social inequities by driving down the road, and disparities were apparent just by existing in the space. This is one of the many examples of passive awareness of inequities. The following section will discuss the presence of levels of critical consciousness that appear across the five career journeys.

5.3 SPD Levels within Black Engineers' Career Journeys (RQ2a)

As a reminder, the second research question focused on identifying the SPD domains and levels within each narrative. This section discusses the trends within each level of critical consciousness (*non-critical*, *pre-critical*, and *critical*).

Across the levels, *critical* was the most prevalent level of critical consciousness, which discusses two categories: (1) identification of *oppressive system forces* and (2) identification of *remedies for oppressive system forces*. The next most prevalent level of critical consciousness is the *pre-critical* level, where the narrators discuss blaming identity groups, environments, people in power, and themselves. Lastly, the least prevalent level of critical consciousness is the *non-critical* level, which captures the narrators discussing the engineering façade surrounding

pathways through engineering and limited self-actualization within the narrators' career journeys. In this section, trends across non-critical (Section 5.3.1), pre-critical (Section 5.3.2), and critical (Section 5.3.3) will be discussed.

5.3.1 Non-Critical Level Trends

In this context, the non-critical (denial) level refers to the instances that the narrators do not consider the individual and social forces that shape people's lives or the identified problem. Within the non-critical level, the narrators discuss their lack of consideration surrounding engineering pathways and how they can manage themselves when presented with a problem. Within the non-critical level, I grouped the narrators' consciousness into three trends: (1) *engineering facade*, which refers to the dream sold to Black engineers around engineering careers; (2) *limited self-actualization*, which refers to lack of realization or fulfillment in one's purpose and/or passion; and (3) *limited action*, which refers to the lack of action in response to injustice.

5.3.1.1 Engineering Façade

Narrators discussed the façade surrounding engineering pathways within the awareness, behavior, and consequence domains. Within the awareness domain, Penguin narrated her lack of critical thought and insight around the perception of the positive impact engineering had on communities:

My interest was captured by hearing various guest speakers discuss the positive impact they had on their respective communities. Even in middle school, at that time, I wanted my future career to be something that I could make a positive difference in the lives of

people and saw engineering as a potential career path to be able to do that given my interest and strong skillset in math and science at that age. (P1)

In scene 1, Penguin fully accepted what engineering was marketed as and based her career trajectory on this perception. This awareness demonstrates an instance of unconscious belief (found in Table 2 and Appendix D) when the narrator takes what they know as all being

On the contrary, in the *consequence* domain, Nina also reflected on taking the career assessment and processing it as all-knowing tool to direct her career path. Additionally, she explained that her interest in engineering lacked any consideration of social forces, stating:

I researched civil engineering, and it discussed broad things that deal with just about everything such as building structures and transportation. I related this description to the game SimCity and found excitement in living the game in real life. I didn't consider the impact that I wanted to make in engineering nor did I even think I was oppressed at this point. I noticed the salary associated with engineering careers and accepted that this was what the universe is giving me. From there, I began my love affair with civil engineering decided to say this was my path until I figure out what I want to do. (N1)

Nina describes how civil engineering presented the idea of unlimited impact and financial freedom. Unlike Penguin, who based her perception of engineering on a personal account, Nina based her perception of engineering on online descriptions. These examples show two vastly different motivations within this sample of engineers pursuing engineering careers. Commonly, they were both sold an engineering façade and based their career paths on these unconscious thoughts.

Like Penguin in scene 1, Vee also discovered the impact of engineering through a guest speaker and based her entire career on this presentation. However, as she navigated

undergraduate engineering, she could not witness the impact that the guest speaker presented. Therefore, she attended graduate in hopes that she would be able to make the desired impact but was limited in making a meaningful impact, stating:

At this point, I am working toward my Master's, and everything about that is just not going well. I went into my Master's study wanting to make a difference in wastewater management. I was drawn to my advisor's work because she operated a pilot sketching plant that used plants for remediating and treating wastewater. In my mind, if you're in a place where the technology of treatment is not readily available, then being able to harness the power of the natural environment to do the work of creating clean water and sanitation seemed accessible. I think she knew what she wanted to do and she saw how I could fold into that. However, she didn't necessarily see how I could expand this work into something that was more meaningful to me. At the time, I didn't have the language to express my needs clearly and I started to just detach a little bit...My advisor started to turn sour on me because of a planning issue, and I started to focus on getting out of there. Overall, I was mentally and emotionally drained. (V10).

She was motivated to make a difference in wastewater management but along the way became discouraged and disconnected from her work for multiple reasons. As narrators discuss suppressing their authenticity and doing what is told due to burnout, I have coded these instances as *non-critical*. The engineering façade resulted in her being mentally drained and losing her passion for engineering as she persisted to the finish line. Some of the narrators that based their career journey on false perceptions of engineering pathways without considering the shape of people's lives or the social forces within the field lost their passion when they realize engineering is not what they initially believed it would be. The engineering façade along the

career journeys have a direct impact on limiting the narrator's self-actualization. In the next section, I will discuss how the narrators lack self-actualization along their journeys.

5.3.1.2 Limited Self-Actualization

Limited self-actualization refers to a lack of realization or fulfillment in one's identity, purpose, and/or passion. For instance, Richard discusses his sheltered home environment that influenced his lack of realization of his identity, stating:

I did not see myself as a low-income, first-generation American, growing up in Brooklyn. In terms of Blackness, there's a different perspective on what it means as an Afro-Caribbean. I was raised in a culture where Blackness wasn't necessarily something to be taught. My Blackness was something that was there that I acknowledged and respected, but it wasn't framed in the context of whiteness. (R1)

In scene 1, Richard explained how he did not realize the social identities he possessed in the context of whiteness.

This trend also includes instances when individuals lack fulfillment in one's passion. For instance, Vee expressed her lack of passion for engineering work stating:

At the time, I was starting to realize I would need to have more passion for the engineering field than what I had to give. I questioned why I didn't have that passion but quickly stuffed that down because I had come too far not to cross the finish line. (V10)

In this scene she was unable to find fulfillment, but she persisted in engineering spaces despite her lack of passion.

In the next section, I will discuss the data trends at the pre-critical level.

5.3.2 Pre-Critical Level Trends

The pre-critical level refers to the instances when the narrator blames individuals or entities for the exclusions of all other systemic factors or social forces for problems or the shape of people's lives. Within the pre-critical level, I grouped the narrators' blaming into four trends: (1) *identity groups*, which refers to groups of people the narrators group together around socio-economic status, regions, race and otherness; (2) *environments*, which refers to context surrounding the problem; (3) *authority*, which refers to people in power; and (4) *self*, which refers to the individual narrator.

5.3.2.1 Stereotype Blaming

Within the narratives, narrators blamed inner-city students, minority groups, and racial groups for identified problems. This pre-critical analysis appeared across awareness, behavior, and consequence. For example, within Nina's narrative, she displayed pre-critical awareness, behavior, and consequence. She demonstrated her pre-critical awareness when she discussed her understanding and awareness of unequal funding within graduate schools, but yet she blamed token minority groups for skewed demographics in funding stating:

The school itself is very diverse but when you start zooming in and looking at actual departments, that's where things start getting a little eerie. Especially as you're looking at graduate programs, it's heavily skewed towards Asian demographics and all of them were fully funded. It felt like I was being penalized for being a Black American since they didn't even give me the opportunity to compete. (N4)

In this scene, Nina blames Asian people for her lack of funding and saw this as a personal inhibitor in obtaining graduate funding. Prior to scene 4, she demonstrated reactions within the behavior domain when she identified her exclusion from resources:

For this reason, I've made it a point to be friendly to everybody, because there would be times when people would share tests. Mind you, because I was a Black student, I didn't have any versions of this test because there weren't a lot of Black students in civil. I networked with everybody because I knew I would get access to all of the stuff I needed to be successful. (N3)

Nina blamed her Blackness for her lack of resources. In scene 3, she discussed consequence s where the outcome blamed individual students for being weeded from engineering programs:

In the orientation, they had us count by five throughout this entire lecture hall of approximately 65 of us and demonstrated how only 20% of us would walk the stage and finish this engineering degree. While I was sitting in that seat, I thought he was just trying to scare us, but it's crazy that he was spot on... I don't think the program itself was doing or not doing anything and these challenges were relatively normal. The program itself wasn't offering resources that could have helped people outside of office hours. However, I was getting similar resources from our minority engineering program, so you had the resources if you sought them out. A lot of students who were ultimately successful ended up using the additional resources. (N3)

As Nina evaluates the drop-out rates, she accentuates that they would be successful if they used their resources, which means that it is their fault for not succeeding. If someone from a privileged background shared the same sentiments of stereotype blaming the results would point to internalized privilege; however, since Nina occupies a low-socioeconomic status and is a Black woman, the stereotype blaming relates to internalized oppression in section 5.2.3.3.

In the next section, I will discuss the instances the narrators blamed the environment for the identified problem or shape of others' lives.

5.3.2.2 Environment Blaming

Environments were considered blameworthy at the education and workplace levels along the sociopolitical journey. For example, Vee discussed her love for social sciences and blamed engineering education environments for separating social and technical concepts stating:

This love for anthropology was never experienced when I was studying differential equations or other classes that I needed to take for my degree. I remember feeling so much more invigorated in environments related to social science in comparison to never feeling like this in courses like statics and dynamics or engineering economics. (V4)

In scene 4, Vee blames engineering classrooms for her sense of apathy. Whereas at the workplace level, Nina's evaluated her positive experiences and attributed her success to the workplace environment when stating:

I finally had my aha moment where I knew where I wanted to be and what I wanted to do. I loved the team that I was on and the mentorship and everything about this position were just phenomenal. Having bosses who are that vested in you is so few and far between, but I was so lucky to have this experience. I went on to being an entrepreneur that prioritizes people and incorporates diverse factors to be an efficient leader in this field. (N7)

Nina describes a positive blaming where she attributes her sense of belonging to her supervision.

5.3.2.3 Authority Blaming

At the pre-critical level, the narrators blame people with authority. Those with power include professors, humanitarian groups, and engineers. For example, Vee discussed being in South Africa and witnessing humanitarian and church groups not asking essential questions:

By being with the local folks, I also witnessed projects that were done by humanitarian groups or church groups who were well-meaning but were not serving the communities

in a compatible way. From the local perspective, they never asked, “is it good for these people specifically?” or “does it integrate into their lives and their values?” (V6)

In this example, Vee explained how empathy played a role in understanding the impact of humanitarian groups coming into communities to do misaligned work.

In the next section, I will discuss the ways narrators in this study blamed themselves for experiences

5.3.2.4 Self-blaming

Lastly, there are instances where the narrators blame themselves. For example, within Richard’s narrative scene 3, he evaluated the first experience of being in a predominately white environment and the outcome of culture shock. As a result, he blamed himself and his white peers for their differences and himself for disagreements:

The biggest challenge is the cultural environment of going to a predominantly white institution and being the only one in many cases. On top of this, the majority of my teachers were white males. Whether within the seminar class or in the engineering classroom, I found myself always dealing with those dynamics. I attended an all-minority school until high school, so college was my first exposure to a more diverse environment. Through this culture shock, there were moments when I became more aware of the duality of who I am, how I look, and how people perceive me. I had friends who were not minorities, and develop strong relationships, but there were moments when I realized I would never be as close to them as their white counterparts just because of their life experiences alone. Even from the outside in, I noticed how they would interact with each other versus how they would interact with me. Some of this could be all perception and not necessarily real but I have these moments all the time. It helped to participate in a

cohort-based program that recruited students from urban settings to attend these predominantly white institutions.(R3)

In this quote Richard explains how his perception of his experiences played a role in his internalization of experiences.

Similarly, when evaluating the need for security and safety to do social justice work, Vee blamed herself for not having that connection between engineering and social justice:

I needed to feel some sense of safety and security to reach into the more extensive social justice work. A sense of security was the foundation of my hierarchy of needs and was necessary to engage in the risk of doing social justice work. Otherwise, the perception of risk surrounding social justice work seems too great. In these moments of working in the consulting firm, I felt like I let folks down or sold out my values because there was a low connection to engineering and social justice. (V11)

In this quote, Vee accurately depicts her hierarchy of needs in integrating social justice work into her engineering practice and feeling guilty for taking the time to establish psychological safety.

In the next section, I will discuss the trends within the critical level.

5.3.3 Critical Level Trends

The critical level refers to the instances in which narrators consider the individual and social forces that shape people's lives or the identified problem. The critical level is distinctive from the pre-critical level because the narrator moves from blaming the identified problem on individuals or entities to identifying the underlying social forces that influence people's lives and identified problems. Within the critical level, narrators discuss their consideration of the individual and social forces that shape people's lives or the identified problem. At this level, when the narrators faced issues or noticed the problems that impacted others, they either

identified the oppressive system forces at hand or identified the antidote that could potentially remedy the oppression of the identified problem. Therefore, within the critical level, I identified two categories: (1) oppressive system forces and (2) antidotes for oppression.

5.3.3.1 Identification of Oppressive System Forces

As narrators discussed the underlying social forces that shape people's lives and problems along the engineering career journey they identified the role of institutional oppression, historical oppression, white supremacy, vulnerabilities, privilege, and professional limitations as the underlying forces that impact their engineering career journeys. For example, Khalil reflected on the underlying details of professional boundaries when stating:

I became more critical of higher education as I engaged with different projects and had the audacity to challenge things that I thought were wrong. When engaging with communities, I would find myself in conflict with team members when I speak up about communities having different perspectives, biases, blind spots, or anything that didn't align with the communities we were working with. Through these conflicts, I noticed patterns and commonalities that were differences in awareness, prioritization of different parameters, and differences in what success is determined to be. For instance, I would define success as equitable solutions that benefit social society with respect to marginalized groups, whether big or small. Whereas oftentimes the groups I was working with defined success as scalable, profitable, and number of publications. (K8)

In Khalil's narrative, he discusses his role in challenging perspectives, bias, and blind spots and how he is faced with perpetual resistance. Due to his high critical consciousness, he looked beyond the resistance and identified the priorities and definitions of success underlying the resistance to equitable solutions.

Furthermore, narrators identified the underlying cause of vulnerabilities that shape communities' suffering. For instance, Richard discusses the impact of getting involved in government entities and the outcome of his duty to bring an equity lens as he approached work problems:

I saw government as a way to make the most impact because I saw how they directly affect the shape of people's lives. Every day I learn something new about systems, how they are built, and how they impact Black people. For instance, I have witnessed lived experiences by working in a service center where people are coming from Puerto Rico because they no longer have a home. Having that firsthand experience, but also knowing what the research says about Katrina, Maria, and the heat waves, I know that disasters impact us. For me, it's really about the focus on the most vulnerable populations that have been impacted by climate change and the issues that they face every day. Even something as simple as residential parking has a racial and equity component. I constantly learn about vulnerabilities through research and doing the actual work. I think there's so much to be learned. (R6)

In this scene, Richard describes his role in the government and how his position enables him to identify how race, equity and vulnerabilities shape people's experience in everyday life. Through involvement in various sectors of society, the narrators evaluated their connections to communities and their responsibility to incorporate equitable practices. Their awareness, behavior, and consequence evaluations of antidotes for oppression were accomplished alongside their identification of oppression systems which will be further discussed in the next section.

5.3.3.2 Identification of Antidotes for Oppression

Within the career journeys, narrators identify several antidotes to addressing social oppression: social integration, high self-esteem, cultural identity, realignment, community engagement, and equity. For example, Vee described the first time she became aware of NSBE and her desire to make spaces equitable:

From there, I found an application of being involved in social justice or equity work and asked, “how do you make space for people and resource them to feel empowered to navigate these spaces that aren’t always welcoming specifically to Black people?” I started to get heavily involved with NSBE, and this space became the greater good of my engineering career. I had two different leadership ranks throughout the organization and spearheaded much outreach, specifically to minoritized students. This consisted of positive affirmations encouraging students that looked like me by saying “you can do this”, and “let me help you.” To me, this meant wedging up the door and providing the resources and encouragement and removing whatever feels like a barrier to them accessing this engineering space and the broad spectrum of their existence in the context of higher education. (V3)

Once Vee became aware of equitable spaces, she immediately perceived this as a space to meaningfully contribute her efforts and leadership. In this scene, Vee saw her engagement as a remedy for oppression. By centering on barriers to others' success, she perceived her role as lifting others up as she persisted through engineering. As a result, she was also motivated to continue. However, on the other end, Khalil thought it was best to leave academia and contribute efforts to space where it is in agreement with one's personal values and measures of success. For instance, Khalil discussed the realignment of incentive structures after leaving academia, stating:

Before this space, I was given consequences for doing this work that I love to do. I felt like a lone wolf fighting to try to get people to understand. For instance, I've been told not to do it since the time and energy spent doing this work takes away from things I'm rewarded for. To me, this means that I wasn't working within an incentive structure that prioritizes community-based work, whereas now, I'm in an environment where I work closely in agreeance with what success looks like. (K9)

For Khalil, his greatest impact was the communities outside of engineering so that he could utilize the skills of engineering to meaningfully engage in communities. In this scene, the realignment of his career enabled him to find the remedy to oppression. The examples demonstrate the ways critical consciousness could be the antidote for oppression.

5.4 Pathways through the SPD process (RQ2b)

This section will answer research question 2b which states: *How do narrators move through the SPD elements throughout their careers?* Utilizing Jemal's (2018) Theory of Transformative Consciousness, I aim to understand how individuals move through the SPD process. Following the narrative construction phase, narrators reflected on these levels and shared their reactions. These reactions supplement the high-level analysis of the narrators' career journeys. The graphs depict the various pathways through SPD along the narrators' career journeys. The level of critical consciousness is displayed along the y-axis, and time, defined by space, along the x-axis. The SPD journeys are categorized by their movement through development into high-sustained, suppressed, and low-sustained.

First, in section 5.4.1, I describe high-sustained development, which is illustrated by Khalil and Richard's pathways through the SPD process. Next, in section 5.4.2, I describe suppressed development which is depicted by Penguin and Vee's pathways through the SPD

process. Lastly, in section 5.4.3, I will describe low-sustained development, which is demonstrated by Nina's pathway through the SPD process. Overall, these descriptors provide examples of how people move through the SPD process.

5.4.1 High-Sustained Development Pathway

The high-sustained development pathway describes a movement through SPD levels that remain high between pre-critical and critical levels. In this dissertation, Khalil and Richard's movement through levels depict high development as shown in Figure 14. As Khalil and Richard navigate SPD, they spend limited time in non-critical levels. In addition, they display high awareness of social forces, high self-efficacy to address social pressures, and commitment to life-long learning.

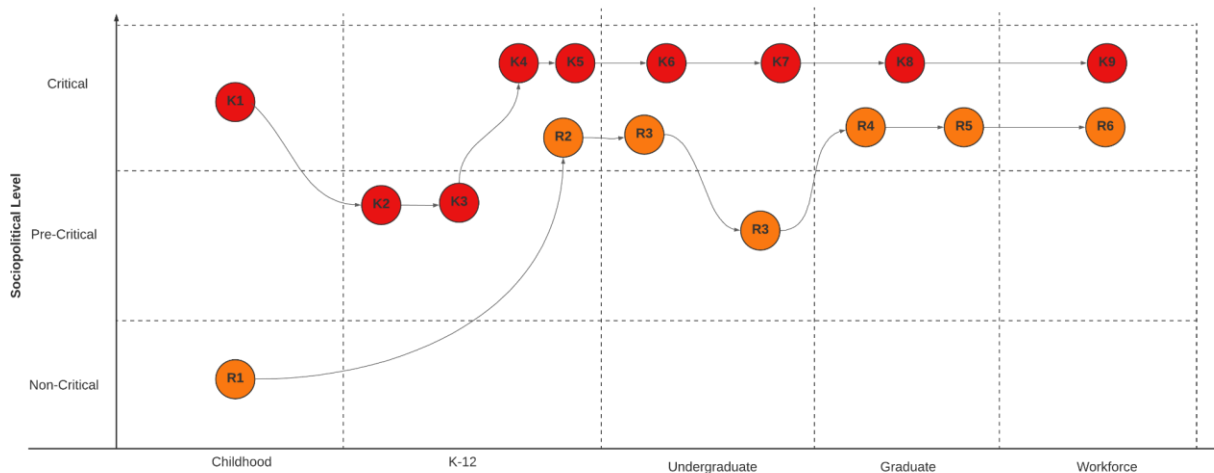


Figure 4. *High-Sustained Development Pathways*

The shape of Khalil and Richard's pathway through the SPD process shows that once they displayed a level of critical consciousness, they could sustain that consciousness throughout various spaces along their career journeys. However, although they could maintain their critical

consciousness, they described instances where they experience each level of consciousness differently than how the transformative consciousness explains. For example, when Khalil reflected on the non-critical level, he stated:

I don't have the audacity to say that I've never been in the first [non-critical] stage because I think I have been but I don't think I'd be there for that long if I'm there. In this list, there's no stage that captures the experience of taking in information. You may not have conflicting information, but you're taking in that information, and you're not believing it, but you're skeptical of it. I find myself in that space and there's no stage between one and two that reflects that experience. When I first got into the international development space, I'm already skeptical from the jump. I'm not in conflict. I'm not discovering, but I'm also not blind believing.

The transformative consciousness framework starts with the assumption that individuals are unaware; However, Khalil demonstrated high-critical consciousness as a child due to his home environment.

On the other hand, Richard demonstrates the building of critical consciousness. In his reflection, he stated:

I definitely think I've been in the denial stage when I was younger. I mentioned I grew up in a very protective home and that I knew things were happening outside the home in terms of identity and marginalized communities. I probably was not using that terminology at that age, but I was aware of it. But it wasn't something that I felt directly impacted me. I was surrounded by Black people and it was only until I went to high school that I had to have daily encounters with white people.

Like Khalil, Richard's home environment greatly influenced his pathway through SPD. He later explained how his Blackness should be celebrated, given his Afro-Caribbean ethnicity. Khalil and Richard were both aware of their Blackness at an early age. However, their consciousness developed vastly differently, given their environments.

Once Khalil and Richard entered undergraduate spaces, their critical consciousness grew and was sustained throughout their career journey. Khalil explained that his ideas were challenged on the end of traditional engineering and community advocacy, stating:

I feel like they [my ideas] are being challenged by very traditional business-as-usual paradigms. For example, like me yelling about social equity, and social inequities and trying to incorporate that into my work through my graduate experience was viewed as troublemaking. They said I was doing too much and asked why should they value that. But doing that exact same thing, in other spaces, like community advocacy group spaces, they're like, you're not saying anything new. Why aren't you doing more? So yes, I am challenged on those things in some spaces and pushed to go further.

Khalil demonstrates how ideas must constantly be challenged and reevaluated to sustain critical consciousness. Similarly, Richard explains the constant interaction of updating his knowledge in his work of providing an equity lens, stating:

Every day I'm learning something new about the systems, how they are built, and how they impact Black people. Every part of my work has a racial and equity component even to the simplest things of those nature. I am constantly asking how these systems can be dismantled. I think there's so much to be learned and you can spend a lifetime doing it. I don't think anyone can really meet the actualization of that last stage but I do think that I'm nearing it.

As Richard reflects on the final stage of liberation, he reveals that freedom is far outside him.

Khalil and Richard both indicated that they have yet to experience liberation. For instance, in Khalil's final reflection on liberation, he states:

Speaking for myself, but this is me attempting to speak for others is but not in an exhaustive manner, people of color, particularly Black folk, and low-wealth folk need good engineering curriculum and supportive environments. Also, a very strong need to do work that we feel is advancing social, racial, economic, legal, political goals, and strategy that is restored to our community. Liberation looks like that need being satisfied. We have a need to be in environments where we can bring our full selves or environments that are supplemental to who we are and what we bring to the table. Not needing to fit into somewhere else, but a place that we just fit together with. Not we have to join them or they have them join us, it just fits well. These are a whole bunch of different needs that I imagine many others need, and liberation looks like all of those needs are being satisfied at the same time. I can't think of one engineering context where that is the case.

Within this reflection, Khalil tried to speak about himself but also believed that he had not achieved liberation until everyone was free.

In summary, the high-sustained development pathway is categorized by limited time in non-critical levels, awareness of social forces, high-self efficacy to address social pressures, and commitment to life-long learning. Next, I will discuss suppressed development.

5.4.2 Suppressed Development

The suppressed development pathway describes a movement through SPD levels that oscillate between non-critical, pre-critical, and critical levels. In this study, Penguin and Vee's movement through levels depicts sporadic development as shown in Figure 15. As Penguin and

Vee’s navigate SPD demonstrate various levels of SPD that depends on the circumstance and environment. They are motivated to empower but not at the cost of their sense of safety and empathy. In addition, their development provides insight into the role of intersectionality, sense of belonging, and value for holistic care on SPD pathways.

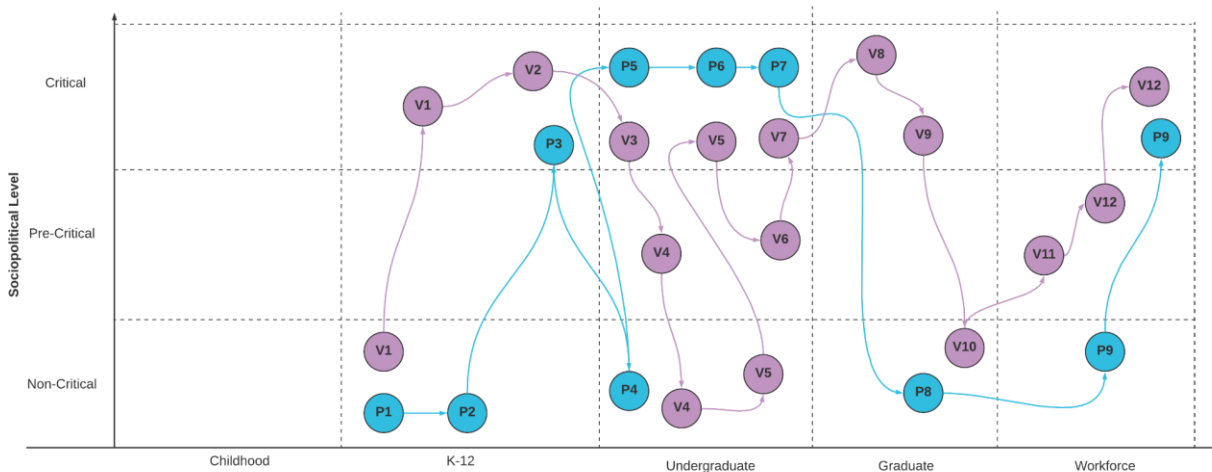


Figure 5. Suppressed Development Pathways

The shape of Penguin and Vee’s pathway through the SPD process shows inconsistency throughout various spaces along their career journeys. Throughout their development, they tend to lean wholly into their critical consciousness. However, at specific points in their consciousness, they believe it is better to suppress their critical consciousness to persist in their career. It is unclear whether their intersectionality plays a role in their abilities to stay entirely critical level; however, both Penguin and Vee demonstrate high levels of critical consciousness and then suppress it.

Penguin and Vee’s journeys demonstrate the internal struggle of coming into one’s full self and owning it. For example, Penguin describes the dance between owning her full self when she transitioned into spaces stating:

It became readily apparent that you're in the school and your professors support you but the working world may or may not be so open to someone of a different background coming in and learning. I think that that duality definitely came into play later in college as I'm interviewing for these internships and later full-time jobs. I'm realizing I'm existing in this semi-cocoon of being in school to now going into the real world and trying to balance being myself while also needing to get a job.

I can't really point to one particular experience, I just felt this conflict of feeling like I need to water down some Blackness or water down femininity to enter what will be this perceived stale world of white, older male engineering-type stuff. I had a lot of identity crises around that, basically, in conjunction with this whole question of, Do I even want to be an engineer?

Penguin described this internal conflict of needing to turn down her Blackness and femininity when applying for jobs. Similarly, Vee can relate when she started to infuse justice work into her engineering career, stating:

I used to go back and forth. I get the pleasure of being in so many marginalized categories. I asked if it was because I'm a woman. Is it because I'm Black? What are the things that make you have trouble accepting my credential, or my value, and my expertise in this space? Which one of these is your issue? But then I asked who gets to stamp you and be like you can do this?

I'm not qualified to do this, just because I am a Black woman. There are specific skills that you have to recognize are needed in this in this space. I reminded myself that this is not new to me. Remembering I begin this work when I was in college. It's not just

what you've done in the lens of your career that has shaped and prepared you to work in this way, but also just what you've been doing with your life.

Although both Penguin and Vee have expertise in engineering, they faced internal struggles with believing that engineering belonged to them. Alongside their engineering journeys, they need to constantly convince themselves that they belong and have permission to do the work they imagine for themselves.

After being there for about a year, I felt a little bit more comfortable, and not having to always navigate in this duality space. But to be frank, I think some of that is always there in the background. I would say now, it's way smaller than it had been in the past, but it may fluctuate from time to time, depending on what's going on.

I'm coming into this industry to help people, but what does it look like to partner with folks and not just come in and say, I have all the solutions, but maybe I come in with a perspective, and the people I'm partnering with come in with a perspective, and we can work together on an end goal.

I'm kind of oscillating between all these different stages and levels, depending on what the day or the ask is, but I try to at least remember that in the back of my mind. I came into this industry because I want to help people. I want to basically continue to check myself to make sure, I'm not disempowering people through the work that I do.

Penguin explains how she is never entirely comfortable, which is needed to express her critical consciousness. The theory of transformative consciousness is limited when it does not consider the need for safety.

Additionally, Penguin and Vee desire not to harm any other value. Transformative consciousness would benefit from an analysis of the overall empathy and care needed as

individuals move through various levels of critical consciousness. For example, Vee also discusses the need not to harm, stating:

If you have a stated value about valuing people and making them feel important and seen and heard, my consciousness is influenced if it doesn't live up to that value and this person leaves an interaction or something that I've created feeling less than seen, valued, and heard. It's just like, you blew it, and that sticks with me.

The desire to address systematic forces sometimes aligns with not harm. However, there are other times when addressing inequities conflicts with empathy, given that everyone does not have the same values.

In summary, through Penguin and Vee's narrative, they are motivated to empower but not at the cost of their sense of safety and empathy. Their suppressed development is characterized by their oscillating level of consciousness, the process of intersectionality, sense of belonging, and value for care.

5.4.3 Low-Sustained Development

The low-sustained development pathway describes a movement through SPD levels that remain low between non-critical and pre-critical levels. In this study, Nina's movement through levels depicts low development as shown in Figure 16. As Nina navigates SPD she spends limited time in critical levels, which is the opposite of high-sustained development. In addition, they display limited awareness of social forces, low-self efficacy to address social pressures, and commitment to sustaining oppressive forces.

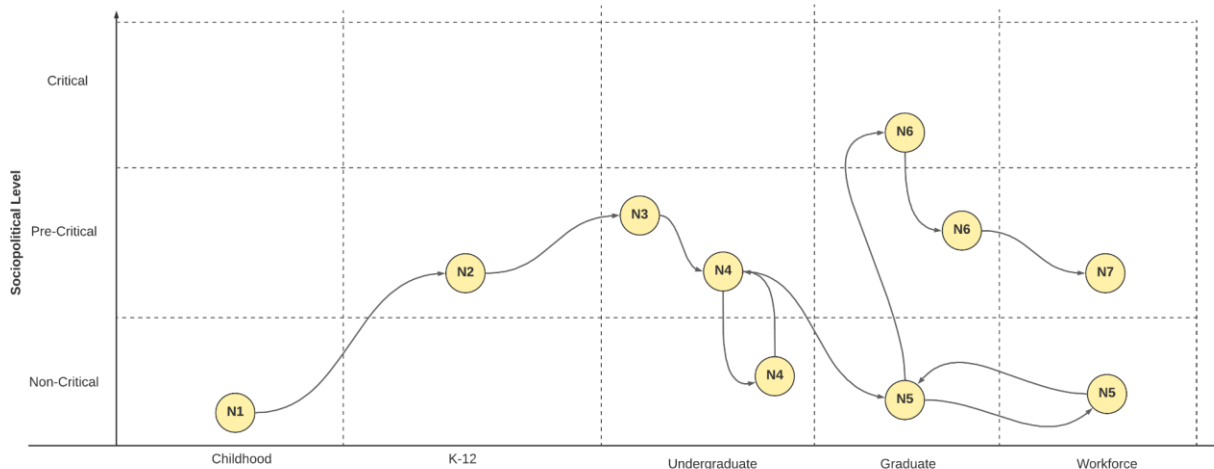


Figure 6. *Low-Sustained Development Pathway*

Throughout Nina’s SPD, she displayed low levels (either non-critical or pre-critical level) of critical consciousness throughout her career journey. In one scene, she demonstrated a high level of critical consciousness; However, the critical level was not sustained. Her high level of critical consciousness referred to her stating she would no longer support PWIs due to her distrust in academia. She continues by saying:

I don’t feel like I thought I was oppressed at that point. I was just like, alright, well, we’re going to just take what the universe is giving me and hope it works.

Nina does not feel like she was oppressed throughout the majority of her career journey, which significantly impacts her SPD process. As we discussed her pathway through the SPD process, she stated:

I find myself just like empathizing more with people who are being oppressed, and trying to help in any way I can. I am just realizing how quickly and easily that could easily be me again, because I think right now, we all like to think we’re safe from that, this isn’t going to happen to us, we have our degrees. I’m like, no, it could easily happen.

But it's weird because within the code of ethics, for engineers, we're technically not supposed to strike, we're not supposed to do all these things. Technically, we could be mistreated and because of our code of ethics, if we choose to follow them, we can't really do a lot of things about it. It's this understanding that as an engineer, we're supposed to still think of the human or the public good. So that public good basically says, hey, you need to work, you need to make sure the needs of the people are always being met. Even if you're being wronged and things like that, it doesn't matter.

Nina believes her engineering degree offers safety from oppressive forces, and contributing to these causes will cost her the protection that the degree provides. She demonstrates empathy toward the public good and does not take the code of ethics for granted. Throughout Nina's narrative, she works hard for everything you have and will not do anything that threatens the status she has now achieved. Nina's narrative is a story of survival, and the need to persist limits her critical development.

In summary, the low-sustained development pathway is categorized by limited time in critical levels, lack of awareness of social forces, low-self efficacy to address social pressures, and commitment to sustaining oppressive forces.

5.5 Summary

In conclusion, each SPD domain and levels are present in the career narratives. Table 12 provides a summary of the trends within each domain and situates the narrative scenes across SPD levels. Various components of the narratives were identified as an SPD level and domain. Scenes found in Table 12 correlated with the identified trends within the SPD levels and domains.

Within the *awareness* domain there exist the role of awareness of self, the utility of actions, social-technical divide, social inequities within communities, inequities existence, and utility of actions. Within the *behavior* domain, I discussed the narrator’s participation in Black culture, developing navigation strategies, questioning knowledge, changing work environments, integrating new perspectives, suppressing emotions, and doing nothing in response to various situations along their career journeys. Lastly, the *consequence* domains discuss the impacts of overt racial/gender discrimination, internalized oppression, isolation, engineering systems, personal well-being, and responsibility.

Across the levels, the *non-critical* level discusses the engineering façade surrounding pathways through engineering and limited self-actualization within the individuals. Whereas, within the *pre-critical* level, narrators discussed blaming identity groups, environments, people in power, and themselves. At the highest *critical* level, narrators discuss instances they either identified oppressive system forces or antidotes for oppression.

Table 12. *The Prevalence of SPD Levels Across Domains With the Career Journeys*

| Level | Domain | | |
|-------|--|---|--|
| | <i>Awareness</i> | <i>Behavior</i> | <i>Consequence</i> |
| | Self; Work utility; Social-technical divide; Social Inequities | Navigating injustices; Participating in Black culture; Orienting authenticity; Questioning knowledge; Suppressing emotions; Doing nothing | Overt racial and gender discrimination; Isolation in predominantly white spaces; Internalized oppression; Sense of responsibility; Engineering systems |

| | | | | |
|-----------------------------------|---|--|---|--|
| <i>Non-Critical Consciousness</i> | Engineering facade; Limited self-actualization | R1, P1, P2, P4, V1 | V10, N4, N5, P8, P9, V4, V5 | N1 |
| <i>Pre-Critical Consciousness</i> | Stereotype blaming; Environment blaming; Authority blaming; Self-blaming | V11, N4, V4 | N3 | K2, K3, R3, V6, N2, N3, N4, N6, N7, V12 |
| <i>Critical Consciousness</i> | Identification of oppressive forces (institutional oppression, historical oppression, white supremacy, vulnerabilities, privilege, and professional limitations); Identification of antidotes for oppression (social integration, high self-esteem, cultural identity, realignment, community engagement, and equity) | K1, K5, K7, K8, K9, R4, R5, P5, P7, V5, V7 | K4, K7, K9, R2, R4, R5, P3, P7, V3, V5, V7, V12 | K5, K6, K7, K8, R3, R6, N6, P3, P5, P6, P7, P9, V1, V2, V9 |

When zooming out to understand how the SPD process unfolds through the career narratives, I identified three pathways: high-sustained, suppressed, and low-sustained development. The high-sustained development provides insight into the need to challenge and question thinking around your metacognition. The high-sustained development pathway is categorized by limited time in non-critical levels, awareness of social forces, high-self efficacy to address social pressures, and commitment to life-long learning. The suppressed development provides insight into the duality of critical consciousness: there is the awareness of systems of oppression and self-efficacy to engage. Individuals' pathways through the SPD process in this category demonstrate a high critical consciousness but lack social agency. The suppressed development is characterized by their oscillating level of consciousness, the processing of intersectionality, sense of belonging, and value for overall public care. Lastly, the low-sustained

development pathway provides insight into internalized oppression and the need for survival.

The low-sustained development pathway is categorized by limited time in critical levels, lack of awareness of social forces, low-self efficacy to address social pressures, and commitment to sustaining oppressive forces. In Chapter 6, I will discuss how the SDP levels and domains are situated in sociopolitical systems.

Chapter 6. Sociopolitical Systems (RQ3)

The following section will discuss the socioeconomic levels in which the domains and critical levels are situated within the career journeys of the five Black engineers. The results in this section answer research question 3 stating: *What sociopolitical systems shape the SPD?* This section will focus specifically on the additional layer of analysis that Bronfenbrenner's (1979) social-ecological systems theory brings to Jemal's (2014) transformative consciousness theory.

The socio-ecosystem levels identified inform how the domains and critical levels of consciousness are grounded within sociopolitical systems. In addition, the model helps identify the contextual factors and relationships between self, others, and community that (1) identify potential causes and solutions at one or more socio-ecological levels and (2) shape an individual's socio-ecological change-making ability or potential, whether the individual produces change or not. Figure 17 provides an illustration of the ways SPD was described within various socio-ecosystem levels.

Across the socio-ecosystem, the *intrapersonal* level was the most prevalent, including self-regulation strategies, internal drivers, and necessary rehabilitation focus practices on the individual level to address oppression. Following with equal prevalence are the exosystem and macrosystem. The *exosystem* level focuses on academic decisions and corporate (for-profit and

non-profit organizations) decisions that indirectly and directly impact the individual interacting with these institutions. The *macrosystem* focuses on the sociopolitical environments within engineering classrooms, norms surrounding elitism in engineering, attitudes towards underperforming students, and Black cultures situated in whiteness at PWIs.

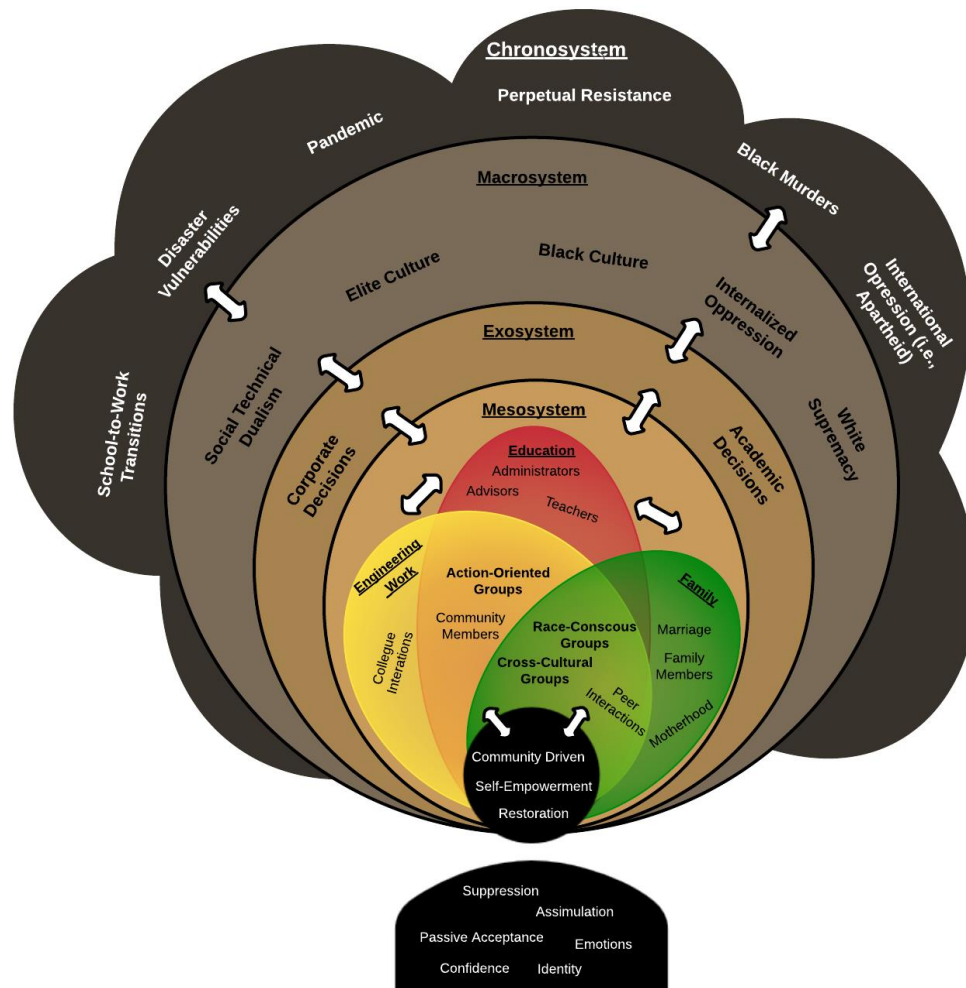


Figure 7. Illustration of SDP Components within Socio-ecosystem Levels

Next, with equal prevalence, is the interpersonal and microsystem level. The *interpersonal* level includes close power-distance relationships or far power-distance relationships that have both positive and negative influences on the individual. At the *microsystem* level, narrators discuss cross-cultural education groups, race-conscious groups, and action-oriented groups. The second to least prevalent level is the *mesosystem* level which

includes work, education, and family influences. The least prevalent level is the chronosystem, which includes socio-historical circumstances, the patterning of events, and transitions over time.

The trends that exist within each socio-ecosystem level will be discussed in the following order: microsystem (Section 6.2), which consists of groups (Section 6.2.1), interpersonal (Section 6.2.2), and intrapersonal (Section 6.2.3), mesosystem (Section 6.3), exosystem (Section 6.4), macrosystem (Section 6.5) and chronosystem (Section 6.6).

6.2 Microsystem Level

The microsystem level includes interactions between groups of individuals closely related to an individual. Within the microsystem, there are interpersonal and intrapersonal dynamics that narrators discuss along their SPD. I will first discuss the groups that narrators mention as they identified socio-structural forces that shaped their lives. Then, I will discuss the nature of interpersonal experiences that underlie identified problems or shape people's lives. Following, I will discuss how social-structural forces impact the intrapersonal experience.

6.2.1 Groups

These groups that narrators discuss influencing their SPD are categorized as either cross-cultural education groups, race-conscious groups, and action-oriented groups.

6.2.1.1 Cross-Cultural Groups

The cross-cultural groups within Penguin and Vee's narratives refer to study-abroad groups. Both narrators participated in study abroad during their undergraduate careers and noted these experiences as essential to their sociopolitical development. For instance, Vee described her reflections on actions of injustice due to being in this environment: "*In these moments, I*

came to the realization about the different ways in which South Africa versus the US have addressed these histories and start trying to move towards rebuilding and making amends, or not, in some cases.” (V5) This shows the potential of cross-cultural education groups on sociopolitical development.

6.2.1.2 Race-Conscious Groups

The race-conscious groups mention in Richard and Vee’s narratives refer to the Black Graduate Association and the National Society of Black Engineers (NSBE). Participation in these groups provided narrators a sense of self and community and increased awareness surrounding the culture they were a part of. For example, at the start of his narrative, Richard described himself as someone who did not think about identity and navigated these spaces without this consideration. However, once he connected with the Black Graduate Association, he gained a sense of responsibility: *“From the new awareness, I grew in understanding of the role I need to play as a professional. I adopted the view that it is my responsibility to help and support other minority engineers along the way.” (R4) Race-conscious groups played an essential role in providing a sense of belonging, self-actualization, and personal empowerment.*

6.2.1.3 Action-Oriented Groups

Lastly, action-oriented groups refer to humanitarian, community service projects, and community organizer groups. Awareness of these groups and participation in action-oriented groups appeared across most narratives. For example, Penguin described the ways her involvement in a community organizer group influenced the ways she saw her agency against oppressive systems stating:

This whole experience opened my eyes to systematic avenues to solving problems in an unconventional manner. Before this experience, I saw inequity as a thing that existed outside of me. I didn't really have a lot of clarity on how it just came about; it was something that exists and has always existed, and you just kind of manage it. Whereas afterward, I think some of that sentiment was still there, but I felt more personal empowerment to do something to help combat it. I know I can't solve the whole issue by my actions or even my team's actions. However, I knew people's efforts to combat inequity can make a positive difference, whether small or big. (P7)

Following her engagement with the action-oriented group, she felt empowered to identify a need and act on it whether big or small. In summary, participation in groups around experience, identity, and action can influence the narrators' critical consciousness about the world around them.

6.2.2 Interpersonal Level

The interpersonal level includes all interactions between individuals. These interactions were categorized as either close power distance relationships or far power distance relationships. Within each category, the narrator describes the influence these interpersonal relationships had on their transformative consciousness.

6.2.2.1 Close Power-Distance Relationships

Close power-distance relationships include peer-to-peer interactions and colleague interactions. These relationships refer to the instances when the interpersonal relationship under analysis is on the same level as the narrator. For example, Penguin discussed her experience with gender discrimination from her classmates in an engineering course, stating:

For my immediate team, all three of us were ladies. In this class, the gender differences were way more apparent given that the class was majority boys, and the three girls were all on one team together. There definitely was a lot of gender bias at play with other male students in the class saying things like, “three girls can’t build a nice sturdy bookshelf for this elementary school”

I have all these experiences in my past to look back on that relate to inequity or injustice and I am aware that it is a thing. I learned how to navigate people who have different personalities and different motives. After time passed, these instances were not a big blow to me, because I had people not be particularly supportive in my past. Since I’d had those experiences in high school, the new experience would just roll off my shoulder. Were they challenging? Yes, but I made it through them. I think I had more resilience to move forward in the future.

The nature of this type of interpersonal relationship within the narratives is either beneficial or detrimental to the narrators’ sociopolitical development.

6.2.2.2 Far Power-Distance Relationships

The narrators discussed administrators, advisors, teachers, and community members within far power-distance relationship categories. As narrators discussed distant relationships with administrators, they described them as beneficial to their sociopolitical development in having examples of people mishandling power. The awareness of people who abuse power in interpersonal relations gave the narrators critical insight into how they can be socially aware of navigating practices when approaching a problem. For example, Penguin demonstrated the ways far-distance relationships could influence transformative consciousness when she responded to the discrimination from her peers:

I would tell my mom and she helped me craft a plan to bring the issues to the administrative staff at the school so that we could actually bring about some course of action. I was learning how to advocate for myself earlier due to these challenges in high school and it lead to me eventually having high self-esteem. We wrote a letter to the principal and dropped it in his mailbox at the school. This led to a one-on-one conversation with the school principal who basically said “we can’t do anything because no one made an explicit threat against you, but we’ve noticed that this is not conducive to the type of student body we want to have.” As a result, no disciplinary action was taken but I think it was eye-opening for me. I learned how to devise strategies for issues where there is multiple staff involved and an individual issue needs to be resolved. (P3)

Although experiencing overt discrimination is not ideal, Penguin describes how she devised a plan to address this issue by writing a letter to the administration and correlated this experience with common inequities she faced along her journey. By identifying people in power, she was able to advocate for herself and if she ever needed to do this again she would have strategies to employ. In the end, her aim was not accomplished but her SPD increased as a result.

6.2.3 Intrapersonal Level

The intrapersonal level includes matters about self and the process that exists with a person (e.g., internal thoughts, attitudes, emotions, and beliefs). Starting at the intrapersonal level, narrators could describe strategies, motivations, and restorative practices that took place within themselves to navigate, persist, or react to systematic oppression. The presence of transformative consciousness was categorized into self-regulation strategies, internal drivers, and necessary rehabilitation focus practices on the individual level to address oppression.

6.2.3.1 Self-Regulation Strategies

Narrators described self-regulation strategies such as assimilation, passive acceptance, suppression, and expression of emotions. For example, Khalil discusses the need to assimilate when he decides to cut his hair before attending a PWI:

I never considered myself someone who incorporated social justice into engineering. Before I enrolled in engineering I knew colonization, capitalism, and racial discrimination existed. Knowing that these systems existed, I cut my hair; not because I wanted to cut it, but because I felt like I had to cut it. I knew I was going to this PWI and I was trying to secure internships. I cut it by simply trying to assimilate in ways I didn't want to, but I felt like I had to. (K5)

Khalil's fear of discrimination pushed him to assimilate in ways he did not initially want to. As we reflected on this situation, he stated that he is always trying to combat his need for "white validation." Similar to male validation, this term refers to the desire to be accepted by the dominant culture and it leads to assimilation.

Whereas assimilation involves changing oneself to fit in, passive acceptance refers to accepting something without consideration. For example, Vee described herself as hearing a guest speaker describe their impact on engineering. Although she was completely unaware of the field, she remembers the positive reinforcement from her community and decided to pursue a career passively, accepting whatever that would mean stating: *"I needed to take care of myself and be a part of something broader than myself. A combination of the positive reinforcement and perception of a career in engineering from my environment led to my decision to pursue an engineering career." (V1)* The perception of an engineering career provided outside validation that pushed her to persist in engineering past her burn out.

In contrast to assimilation and passive acceptance, suppression refers to considering thoughts, insights, reactions, and evaluative processes. However, this consideration is rejected or dismissed. For instance, when Vee recognized that she was having conflict with being an engineer in scene 8, she suppressed the feeling because she didn't want to waste time:

I had to get this engineering degree, and this love for the community was interfering with the main goal of getting this engineering degree. So I just went through these social courses and said, "Ok, that was fun" and went back to the primary goal at hand. (V8)

Similar to assimilation and passive acceptance, Vee is demonstrating suppression of passions and identity to obtain an engineering degree. In reflection, narrators regretted these decisions, because it resulted in internal conflict. In summary, regulation strategies were mentioned by the narrative as internal thoughts and beliefs that they contained within themselves to persist in engineering careers.

6.2.3.2 Internal drivers

Narrators' internal drivers reference motivations for pursuing an engineering career and making spaces for voices to be elevated that were beyond themselves. This refers to the collective community that exists at an intrapersonal level. Internally, the narrators carried visions and ideals for communities that motivated them to persist. Khalil described this in Scene 8 when he was able to find internal comfort with his career stating:

In my new workspace, I am more engaged with community-based organizations and coalitions and serve more in a service role versus a research role. I found more fulfillment, by being engaged with communities, organizations, and coalitions. It was hard to have the level of engagement that I wanted through the group-seeking programs.

Whereas, now that it is part of my actual job and I'm being paid to do it, it is both more fulfilling for me and essential to being successful in the work that I do. (K9)

Khalil explains his definition of success that only he can define for himself. In conclusion, at the intrapersonal level, individuals describe attitudes and emotions that motivate their career journeys.

6.2.3.3 Restoration

Scholars debate the benefits of SPD, but the risk associated with critical consciousness is not often discussed. Lastly, restoration components within the narratives include confidence, empowerment, and self-restoration. Vee discussed the need to take time to find the security and safety to do social justice work.

I needed to feel some sense of safety and security to reach into the more extensive social justice work. A sense of security was the foundation of my hierarchy of needs and was necessary to engage in the risk of doing social justice work. Otherwise, the perception of risk surrounding social justice work seems too great. In these moments of working in the consulting firm, I felt like I let folks down or sold out my values because there was a low connection to engineering and social justice. However, in processing through therapy, I learned that in these moments, I was trying to survive and had every right to practice this self-care. While focusing on my career and family, I was piecing myself back together by finding joy, safety, fulfillment, and overall peace. (V11)

Vee explains how safety and security is situated in the hierarchy of needs for engaging in social justice work. As narrators engage in this work, self-care is essential to persist and challenge systematic oppression. In scene 12, Vee explains how self-care is liberating stating: *My personal liberation benefits the way I can show up in these engineering spaces and challenge some of the*

things that maybe no one would have challenged before. (V12) The balance between liberation and SPD is maintained by taking time to restore. Restoration is necessary as they are motivated to address social inequities along their career journeys.

6.3 Mesosystem Level

The mesosystem level includes interactions between different parts of a person's microsystem (e.g., family, schools, and jobs) in which the microsystem influences each other. I noted which parts of the systems pushed against the other in this analysis and identified that they were either influenced by work, education, or family.

6.3.1 Engineering Work Influences

Work influences include incentive structures and perceived impact within engineering work. For instance, Nina was able to recognize that the different spaces influenced the type of impact she would make. She was happy about the work she was able to accomplish, but due to the need for a different lifestyle and marriage demands, she came back to engineering:

Then I got married and had to come back to engineering. My husband has expensive tastes and I had to figure out how to finance those expensive tastes. Although the psych degree makes me happy, it doesn't finance expensive taste so I enrolled in graduate school for the second time. (N5)

This shows how family structures can push against work structures. In addition, Nina mentioned how her experience in one field influenced her perception of the other: *"As a psychologist, I felt I was making a difference by reuniting families and dealing with substance abuse. With engineering, I felt like I was lining some white guys' pockets more than I am making a difference."* (N6) In this scenario Nina is depicting the nature of work in one space can influence

the perception of work in another space. This is essential to consider how SDP manifests in interdisciplinary spaces.

Next, I will discuss how education influences microsystems.

6.3.2 Education Influences

Education influences include public schools and academic environments that influence groups of people. For example, Khalil discussed his community activist role before becoming an engineer. He did not go into great detail about his engagement with international and domestic advocacy groups, but he mentioned his participation in these groups as essential to his critical consciousness development. He explained:

I went through my degree program with the motivation to engage in action. However, as I engaged, I started to learn more about the limitations and constraints, and false solutions that academia holds even in those types of spaces that claim to address social inequities. (K6)

He evaluated the motivations within these engineering environments, considering that academia presented particular limitations and false solutions. However, he was confused by these limitations because he saw places where goals could be achieved. Scene 6 demonstrates the critical consciousness development within the educational environments and its influence on education.

6.3.3 Family Influences

Lastly, family influenced other microsystems within Richard and Khalil's narrative when they describe being raised in a sheltered or highly critical conscious environment. Family environments were essential to individuals' sociopolitical development. For instance, Richard

described always being around Black people, given his Afro-Caribbean first-generation status. Therefore, his enculturation in Blackness differed from those who grew up in America. He illustrates this by stating:

Growing up in Brooklyn, I did not see myself as a low-income, first-generation American. In terms of Blackness, there's a different perspective on what it means as an Afro-Caribbean. I was raised in a culture where Blackness wasn't necessarily something to be taught. My Blackness was something that was there that I acknowledged and respected, but it wasn't framed in the context of whiteness. Of course, whiteness is there given by the Queen of England, but it's a little different. I was surrounded by Black people until I went to high school. (R1)

Richard describes the otherness of Blackness when it pushes against school environments. Conversely to Richard's experience in a shelter environment, Khalil was exposed to Blackness and socioeconomic status at a young age stating:

The experiences that influence my parent's perspective exposed me to systems of oppression and were also integrated into the framework in which they raised me. In addition, I have also had my personal experience with different injustices being exposed either directly or indirectly through experiences that my friends and family have had. For example, my parents and I lived in affordable housing, and I reflect on this as I engage with communities of low income. (K1)

Khalil describes how his parents influenced his upbringing and as a result this also impacting the engineering work he sought to accomplish in communities. In summary, interactions between different parts of a person's microsystem influence others' experiences within another microsystem. Next, I will discuss the exosystem level.

6.4 Exosystem Level

The exosystem level includes interactions between institutions in which the individual plays no role in the decision-making process, but it directly or indirectly impacts the individual level. Across the narratives, these instances were categorized as academic decisions, corporate (or for-profit institutions) decisions, and non-profit organization decisions. Each of these decisions consisted of both direct and indirect impacts. Direct impacts are the immediate and measurable consequences of an action or event, while indirect impacts are the secondary or unintended consequences that follow.

6.4.1 Academic Decisions

Academic institutional decisions in the narratives include funding, curriculum, and placement decisions. For example, the institutional decision not to fund master-level graduate students directly impacted Nina's decision to graduate school. She stated:

The school itself is very diverse but when you start zooming in and looking at actual departments, that's where things start getting a little eerie. Especially as you're looking at graduate programs, it's heavily skewed towards Asian demographics and all of them were fully funded. It felt like I was being penalized for being a Black American since they didn't even give me the opportunity to compete. (N4)

Nina discussed feeling like she was personally penalized for being a Black American since the graduate school would not fund her. On the other end, Vee's placement in the "talented and gifted program" demonstrated an indirect impact on Vee's isolation:

I initially believed I was placed in "special and talented" environments due to my own efforts. Over time, you start to see those spaces don't necessarily reflect an even split of the overall school. In this exclusive space, I became the minority in that way. As I got into

the honors and AP courses, I found myself again in a group that didn't match the demographics of the overall school. (V2)

This course typically utilizes standardized testing to find “talented” students and is baked in meritocracy. Academic institutions would need an equity analysis in order to identify the impact of their decisions on equity. In summary, academic decisions indirectly and directly impact the narrators’ socio-political development.

6.4.2 Corporate Decisions

Similarly, corporate decisions also, directly and indirectly, impact sociopolitical development. Penguin’s narrative is an excellent example of this because she is a professional engineer in the industry. Again, an example of direct impact is demonstrated in Penguin’s narrative as she witnesses malpractice towards disadvantaged communities, stating:

While at the internship, the plant had some issues getting some recycled water projects approved, because they were pissing off the people that lived on the backside of the area where the recycled water pipelines would be expanded. The agency was trying to shoehorn the project to meet a funding deadline which didn't go over well because they didn't build in time to talk with the neighbors to hear and understand their concerns. If they did build in this time, they could come up with a solution that would work for all parties involved. Anything that deals with people is not as cut and dry as doing calculations and it must be accounted for in project considerations. This was another example of where I saw these technical and social elements melding together and noticed that you can't deal with them independently. As my awareness grew of the challenges surrounding this one project, I started to chip away at this hard separation between social and technical and brought more awareness to their intertwined nature. (P6)

By witnessing malpractice, Penguin was able to learn from their mistakes of not asking essential questions before engaging with communities. Similarly, Vee witnessed organizations come into communities and have misaligned values from the local perspective stating:

By being with the local folks, I also witnessed projects that were done by humanitarian groups or church groups who were well-meaning but were not serving the communities in a compatible way. From the local perspective, they never asked, “is it good for these people specifically?” or “does it integrate into their lives and their values?” For this very reason, I went to grad school because if I wanted to be in the Peace Corps, and I wanted to know more things about this space. I didn’t want just to be someone straight out of school thinking I was helping people, but I was actually making things worst. (V6)

Vee was not a part of the community, so this did not directly impact her. However, this indirectly influenced the effect she desired to make in communities. In both cases, they witnessed for-profit and non-profits come in and attempt to impact communities without intentionality. As a result, these organizations made an impact on the narrators SPD surrounding community engagement.

6.5 Macrosystem Level

The macrosystem level includes the sociopolitical environment, culture, norms, values, laws, attitudes, and ideologies. At this level, the narrators mentioned the sociopolitical environments within engineering classrooms, norms surrounding elitism in engineering, attitudes towards underperforming students, and Black culture surrounded by whiteness at PWIs.

6.5.1 Sociopolitical Environment

The sociopolitical environment is often challenging to describe in narratives. However, as the narrative around social-technical dualism unfolds, they discuss this as a phenomenon baked

into the understanding of engineering practice. For example, within Penguin's voyage, she discussed the experience of having the social-technical divide present within the engineering classroom by stating:

Before my time in Japan, the separation between people and technology was largely due to how engineering was framed in an academic context in America. When studying engineering, you're solving technical problems and the technical evaluations are the only thing that matters. The technical perspective is a very narrow kind of lens. The nature of these problems was not cut and dry as my American professors presented them. (P5)

As she describes this social-technical separation, she tells its subtle nature but a clear message. Within the macrosystem level, narrators described complex phenomena; however, most in the environment know and accept the present.

6.5.2 Norms

Norms also communicate the subtle nature of environments. In this context, it is a standard or expectation that is widely accepted within specific groups. For example, Vee describes the elitist expectations received within engineering as she states:

Until I reached the experience marker, I understood people would disregard what I could bring up in terms of environmental justice and social equity in engineering practice due to observations throughout my career. Not speaking on the group overall, but in my observance of engineers, we can be kind of elitist. I knew if I had that credential, I would be able to address the comments surrounding why they should listen to this woman talk about this subject. I also wanted the credential to prove to myself that I could do engineering work and that I was a real engineer. (V12)

The elitism around engineers is widely accepted within engineering.

6.5.3 Attitudes Toward Underperforming Students and Deficits

The attitudes toward underperforming students is a common narrative surrounding engineering navigation for specific groups of people. For instance, engineering culture celebrates bell-curve test results and weeding out students in the first semester. Engineering departments are rewarded for their rigor and selectivity. Since this is a commonly held attitude and shared belief, this finding is situated in the macro system. An example of this is when Nina states:

In the orientation, they had us count by five throughout this entire lecture hall of approximately 65 of us and demonstrated how only 20% of us would walk the stage and finish this engineering degree. While I was sitting in that seat, I thought he was just trying to scare us, but it's crazy that he was spot on... I don't think the program itself was doing or not doing anything and these challenges were relatively normal. The program itself wasn't offering resources that could have helped people outside of office hours. However, I was getting similar resources from our minority engineering program, so you had the resources if you sought them out. A lot of students who were ultimately successful ended up using the additional resources. (N3)

Attitudes towards the underperformance of groups demonstrate lower levels of critical consciousness, given that they are unaware of social forces. From this perspective, they believe that if one person can make more, everyone can. Therefore, if they are not being successful, this means they are not trying hard enough. This attitude can have negative impacts on specific groups of people.

6.5.4 Culture

Culture is a challenging phenomenon to analyze. Culture refers to the shared beliefs, values, customs, behaviors, and artifacts that characterize a group or society. However, in

predominantly white environments, narrators name whiteness and its presence without describing culture. Therefore, we narrators specifically call whiteness or Blackness. I categorize this as culture. For instance, in scene 8, Vee described whiteness as aggressive, stating:

The climate felt more aggressive, or more overt with its white supremacy due to people's silence and complicity around the issue. I felt like I was expected to go in and do the work unfazed while, on the other hand, hearing commentary denigrating this boy who was killed for just being a boy in a place someone thought he didn't belong. The way folks reacted to that and turned a blind eye led to the perception that white spaces are not safe the way I initially thought were. (V8)

Vee's perception of overt white supremacy pushed her to participate in Black culture within this predominantly white environment to be surrounded by Black culture. In this scenario, the culture appears botherless; however, the cultural phenomenon extends beyond this. Naming whiteness and its influence on culture demonstrate a higher level of critical consciousness within the macrosystem.

6.6 Chronosystem Level

The chronosystem level refers to the patterning and cumulative effects of events and transitions manifesting over time or through the individual's narrative, along with socio-historical circumstances that shape the individual's context. With the five career journeys, they discussed socio-historical circumstances, the patterning of events, and transitions over time.

6.6.1 Socio-historical Circumstances

The narrators mentioned socio-historical circumstances that shaped their SPD around Black murders, Apartheid, slavery, and the impacts of disasters. Vee specifically discussed the

impact of the Black Lives Matter movement while she was in undergraduate and graduate school, stating:

I think that was the first moment where I saw the connection to a larger social happening and what it said to be to be folks who are considered quote-unquote “elite Black folks” who are in in the world being changemakers and geniuses when at first glance wouldn’t even be considered engineers if we didn’t say it.

We were all standing in this place of privilege and still holding ground to make the statement that, “we are Black in a way that he is Black, and we have struggled in the ways he has struggled, and we could easily be victimized and the way that he was.” We can never forget and let these murders be diminished because of whiteness’ wrong perception of who Black people are in this larger picture. This was a pivotal moment for not only NSBE but for me personally because I remember taking that into grad school with me. I remember also being the first inching toward a louder voice when it came to social justice issues. (V8)

Vee discussed the intersection of her elitism as a Black engineer while also acknowledging her connection to victimization on a greater level. The narrators also discussed their historical understanding of community vulnerability and their historical analysis of disasters. The socio-historical circumstances surrounding the narrator’s *awareness* and *consequence* of events provide the need for SPD development that may potentially have implications for behavior. For instance, Black narrators discuss their responsibility to provide an equitable lens to address the historical harm.

6.6.2 Pattering Events

Narrators also provide evidence of harm in their *awareness* and *consequence* domains in regard to constant resistance to ideologies along their career journey. For example, Khalil describes the influence of perpetual conflict with team members and how this contributes to his analysis of academia, stating:

Through these conflicts, I noticed patterns and commonalities that were differences in awareness, prioritization of different parameters, and differences in what success is determined to be. For instance, I would define success as equitable solutions that benefit social society with respect to marginalize groups, whether big or small. Whereas, often times the groups I was working with defined success as scalable, profitable, and number of publications. (K8)

This is an example of cascading events that influence the narrator's SPD.

6.6.3 School-to-Work Transitions

The school-to-work transition impact SPD because the narrators could make decisions about the work and impact they want to make with their engineering expertise. This was also the space where they found their sense of belonging. For instance, Khalil described his transition from academia to work with community advocacy groups stating:

Before this space, I was given consequences for doing this work that I love to do. I felt like a lone wolf fighting to try to get people to understand. For instance, I've been told not to do it since the time and energy spent doing this work takes away from things I'm rewarded for. To me, this means that I wasn't working within an incentive structure that prioritizes community-based work, whereas now, I'm in an environment where I work closely in agreeance with what success looks like. (K9)

His analysis of the pattering of events in academia influenced his sense of belonging within a service role. In summary, analysis of circumstances and events in the chronosystem level influences how individuals move through the SPD process.

6.7 Summary

Across the socio-ecosystem levels, the intrapersonal level discussed self-regulation strategies, internal drivers, and necessary rehabilitation focus practices on the individual level to address oppression. Then the interpersonal level includes close power-distance relationships or far power-distance relationships that have both positive and negative influences on the individual. At the microsystem level, narrators discuss cross-cultural education groups, race-conscious groups, and action-oriented groups. Next, the mesosystem level includes work, education, and family influences. Following, the exosystem level discusses academic decisions, corporate (or for-profit institutions) decisions, and non-profit organization decisions that indirectly and directly impact individuals interacting with these institutions. Whereas the macrosystem discusses the sociopolitical environments within engineering classrooms, norms surrounding elitism in engineering, attitudes towards underperforming students, and Black cultures situated in whiteness at PWIs. Lastly, the chronosystem includes socio-historical circumstances, the pattering of events, and transitions over time.

7. Chapter 7: Discussion and Conclusion

7.1 Introduction

The purpose of this multiple case narrative study was to explore the process of sociopolitical development within five Black engineers' narratives who are inspired to address social inequities through their engineering work. This chapter will identify its contributions to relevant literature.

This study aims to make marginalized ways of existing and practicing engineering visible through the outcomes of this study. Therefore, I captured the heterogeneity of Black engineers' journeys in engineering with an anti-deficit approach by emphasizing how consciousness influences navigation through engineering structures. By showing how Black engineers use engineering degrees to address social inequities, this study aims to inspire engineers who seek to understand how engineering paradigms can incorporate social justice and provide valuable methods for accomplishing these goals.

In this chapter specifically, I will outline the literature gaps provided in Chapter 2 and directly speak to how my study contributes to the literature surrounding SPD in engineers. The literature review in Chapter 2 has presented significant insights into the literature gaps that this dissertation study addresses. The critical literature gaps are as follows:

LG1: There are limited narratives of engineering work that account for diverse engineers.

LG2: There is a limited understanding of how to best integrate social justice elements in engineering practice.

LG3: There is a limited understanding of Black engineers' professional identity beyond the university context.

LG4: There is limited understanding of how Black engineers' SPD manifests over time.

Sections 7.2-7.5 will address each literature gap respectively. Following, section 7.6 will extend this discussion to the literature on the interconnection nature of systems of oppression. Then section 7.7 will identify key implications for engineering stakeholders and research on socio-political development. The outcomes of this study will enlighten our understanding of the development of critical consciousness in Black engineers' career journeys. Additionally, my findings will equip engineering educators and employees with the insight needed to support marginalized engineers' sense of self in their professional development.

7.2 A Case for Epistemological Diversity (LG1)

Contribution: My study advances the narrative of engineering work documenting five Black engineers' narratives to argue for epistemological diversity. My findings provide race-consciousness evidence of engineers driven by community values and authenticity, which could change how we consider typical engineering work. My findings also highlight how these engineers are met with resistance due to epistemic injustice.

As discussed in Chapter 1, the National Academy of Engineering (NAE) proposed a unifying set of priorities for engineers in the 21st century through a report on Grand Challenges for Engineering (NAE, 2008) that have received a significant amount of support from engineering stakeholders (e.g., researchers, educators, practicing engineers, and policymakers). These grand challenges include priorities such as advancing personalized learning, providing better healthcare, improving urban infrastructure, making clean water more accessible, increasing living standards, and much more (NAE, 2008). To address these challenges, we must encourage engineers to approach problems outside the normative narrative of engineering work. My study findings highlight sociopolitical development within engineers along their journey to demonstrate how engineers have been equipped with the analysis to address these grand

challenges but have lacked stakeholder support. Within this study, I document how socially conscious engineers were tokenized and marginalized within their engineering environments, making their epistemological contributions invisible or rejected within the normative narrative of engineering work.

My study advances the topic of the “in/visibility paradox” by drawing connections to epistemic injustice. Given Faulkner’s (2009) studies on the “in/visibility paradox” in engineering culture, I expected my narrators to discuss being invisible in their participation in activities while being hyper-visible by drawing attention to their race, where whiteness is seen as the norm. However, my narrators primarily focused on their visibility in participating in activities while also being devalued in their epistemological contributions.

My findings present narratives of women and men navigating this paradox and the tensions between conforming to engineering culture and being authentic in the confrontation of power and privilege throughout their environments and life experiences. The narrators being tokenized in engineering spaces found themselves being used to promote diversity in engineering spaces. However, their internal desire to be authentic in their methodology of engineering work is faced with resistance from engineering culture that places this work outside their margins. Engineering culture emphasizes a narrow definition of engagement that values technical advances over community impact. Some narrators in this study situate their identity in collectivist cultures; therefore, they carried visions and values of communities with them as they integrated into an engineering culture. For example, near the end of each narrator's career journey, they reflected on their personal path of becoming an engineer. They discussed the sense of responsibility they hold as Black engineers to give back to their community. At baseline, each narrator believed in inclusive environments and removing barriers that shape people’s lives. For

instance, scene 9 of Penguin's narrative discussed entering the field to help people, desiring to bring an equitable lens, and hoping for a shift in the ways we do engineering holistically.

These narratives identified the ways some engineers show their authenticity by making an impact on the community and bringing an equity lens. However, engineering culture presented barriers for narrators that did not conform to these norms to be accepted and succeed in the profession. Prior literature on the role of social context and significant life experiences highlights the importance of a synergistic relationship between practice and reflection (Kuang & Zhang, 2021; Kirschner & Martin, 2020; Chang & Chang, 2019; Martín-Baró, 1994). My study findings on SPD development extend this discussion by emphasizing the role of events, environments, and individual characteristics on various levels that impact how individuals navigate SPD within engineering cultures. For instance, Chang and Chang's (2019) study discusses the role of critical self-reflection in integrating meaning, purpose, and personal growth in life. Through my study's design, each narrator discussed their reflections and needs to align their values and epistemological knowledge within their engineering practices. As some of the narrators maintained high critical consciousness, they constantly address the need to reflect and challenge ideas. They were rewarded with personal satisfaction as they expressed the need to act on their sense of agency. However, they were also combated with challenges that resisted their sense of agency which could potentially result in the need to suppress their SPD. The suppression of SPD within engineering environments directly relates to epistemic injustice in engineering culture.

My study contextualizes the experiences surrounding epistemic injustice within engineering culture by highlighting how motivations to address inequities are devalued. Recent literature on epistemic injustice has emphasized the role of power and privilege in knowledge production and dissemination. My study findings extend this discussion to engineering

environments where some narrators face conflict in addressing inequities. According to Fricker (2007), epistemic injustice is when someone is treated wrongly in their capacity as a knower, such as when they are not believed or excluded from knowledge production. In addition, Medina (2011) emphasized the role of power and privilege in perpetuating epistemic injustice knowledge production. Within the career narratives, narrators experienced a deliberate devaluing of their contributions by their colleagues. Narrators in this study found themselves in perpetual conflict with dominant groups controlling the means of knowledge production and dissemination when it comes to integrating intentional community practices. For one narrator's career journey, the journey concluded with him moving to a service role where his insight was valued and contributed to his desired impact. Epistemic injustice leads to the exclusion or marginalization of alternative perspectives and ways of knowing outside the dominant group.

My study advances discussion on the impact of epistemic injustice in engineering environments by highlighting how epistemic injustice will devalue the contributions of any engineer outside of the white, cis-male norm; while claiming diversity as a value within the field. The typical narrative surrounding engineers in work environments is that they are atypical workers lacking social agency and bound by the real-work constraints of their bosses and technological environment (Winner, 1986; Riley, 2008; Cech 2014; Leydens and Lucena, 2018). However, the findings provide a counter-narrative to these engineers because I identified some engineers enacting social agency in their most authentic ways against work constraints within their engineering environments.

My study advances this discussion by highlighting how engineering work centered on whiteness makes people of color's conceptualizations of engineering work invisible. For instance, Khalil discussed how he was punished for working with community activist groups and

felt isolated in the engineering community due to the absence of values for engagement. The separation of community-based work in engineering creates a segregated engineering work culture where values of some people of color are brought into a white-dominated culture. In the engineering work, they are measured by outputs (i.e., number of publications and industry profits) that devalue outputs aligned with community-based work. My study provides evidence that the notion of in/authenticity can be expanded to incorporate the impact of race on white-dominated engineering spaces (Douglas et al., 2019; Dietz et al., 2019). Within engineering environments, it is essential for people of color to be able to choose avenues for authenticity and community engagement as their social awareness increases. Promoting sociopolitical development in all engineers could help create a more inclusive and equitable engineering culture for not only people of color but for engineers seeking to incorporate authenticity and community engagement in engineering work.

Prior literature surrounding the biases and predispositions engineers utilize when evaluating complex situations that impact people's lives presents the typical engineer as someone who relies on technical solutions. However, my study contradicts this view by acknowledging the development of engineers' political, social, and civic responsibility. Characteristics of engineers' ideation of the public include a value of scientific evidence, artificial separations between views of industry/governments, and starting with belief or disbelief in the community's claims and basing broader judgments about the public and the value of other knowledge on that belief (Canney and Lambrindou, 2018). In contrast, my study's findings for RQ2b provide evidence of the existence of a socially conscious engineer who constantly challenges their metacognition, is keenly aware of social forces, maintains a high-self efficacy to address social forces, and commits to lifelong learning.

My study aligns with literature that discusses how critical consciousness through social-technical interactions could potentially increase diversity in engineering (Litchfield and Javernick-Will, 2015; Adams et al., 2011). However, it slightly differs by highlighting epistemic diversity's importance beyond visual representation. Litchfield and Javernick-Will's (2015) mixed-methods study on socially engaged engineers found that engineers participating in Engineering Without Borders have broader interests and motivations for engineering work than non-members. However, it does not discuss how socially conscious engineers engage with action-oriented programs such as Engineering Without Borders and are also motivated to utilize non-traditional methods to advance how we accomplish engineering work. Using a multiple perspectives methodology, Adams et al. (2011) map an innovation landscape for what it means to engage future engineers with epistemological development and social justice innovations. My findings provide evidence of the benefits of epistemological diversity beyond the traditional ways of doing engineering work to address the complex challenges in society.

7.3 Utilizing Agency to Integrate Social Justice in Engineering Practice (LG2)

Contribution: My study advances the understanding of how to best integrate social justice elements in engineering practice by acknowledging the ways Black engineers are socialized through their engineering preparation. My findings prove that as most Black engineers in the sample navigate their engineering education, they enact their agency against ideological pillars surrounding engineering education by remaining socially aware, community-centered, and politically engaged while still participating in engineering work. However, individual conceptualizations around engineering ethics limit the desire to engage in communities, and this can be addressed through critical consciousness.

My study findings highlight how some Black engineers enact their agency against ideological pillars surrounding engineering education by remaining socially aware, community-centered, and politically engaged while still participating in engineering culture. As previously discussed in Chapter 2, the literature highlights the collective decline in social awareness, meanings, and practices surrounding engineers' conceptualization of their professional responsibility amidst public welfare concerns. My study contradicts this finding by highlighting how some Black engineers can navigate SPD at higher levels (pre-critical and critical) throughout most of their engineering preparation.

Prior literature on engineering's culture of disengagement argues that the exclusion of public welfare in engineering has been maintained by three ideological pillars: technical/social dualism, individual meritocracy, and depoliticization. My study contributes to this discussion by identifying how some racially minoritized engineers push against the dominant culture of disengagement and utilize critical consciousness to persist within engineering environments despite the "culture of disengagement." My study highlights how high levels of critical consciousness enabled most individuals to identify oppressive systematic forces and antidotes to remedy the impact of these social forces. The oppressive forces identified by the narrators align with the ideological pillars defined by Cech (2014). However, my study differs slightly by identifying the role of whiteness and intersectionality in upholding the culture of disengagement within engineering careers. Furthermore, incorporating the analysis of critical consciousness allows me to extend our understanding of these ideological pillars and how individuals enact their agency as they navigate engineering culture.

Given past research about undergraduate engineering students and their limited sense of agency in impacting society, I expected narrators to discuss their awareness of social forces and

limited agency to engage during their undergraduate experience. However, my narrators reflected on their undergraduate experience and described it as a place where they could freely demonstrate agency in addressing social inequities in society. Scholars examining large datasets have shown evidence that undergraduate engineering students are less likely than undergraduate students in other fields to believe that an individual can change society, to describe themselves as socially concerned, or engage in promoting racial understanding or social action (Astin, 1993; Sax, 2000). However, Vee describes her first-time understanding of her sense of agency, social concern, and engagement in social activities during the second semester of her first year in scene 3. Vee discussed the lack of connection to women in engineering programs and the sense of belonging and empowerment when she finally found NSBE. For Vee, the National Society of Black Engineers (NSBE) provided her connection to other Black engineers, which in return allowed her to be a part of something greater than herself. This experience demonstrates that connection to communities inspires action to engage in equity work. A sense of agency within community equity work around engineering space can be enacted despite the ideological pillars surrounding the culture of disengagement for some Black engineers.

Morgan et al.'s (2019) research on students' political identity development points to the tension between engineering and social justice. Therefore, I expected my narrators also to explain the tension between engineering and social justice. Instead, my narrators discussed feeling invigorated when they had opportunities to understand social inequities surrounding their work. Morgan et al.'s (2019) findings reveal internal tensions that shape engineering students' political involvement, including limiting exposure to motivating political events, privileged private gain, and political positioning at engineering borders. In contrast, some of my narrators found limited internal conflicts with incorporating politics into their engineering work. These

narrators expressed the multiple instances they were exposed to motivating political events, devalued private gain, and their conflicts with the political position of engineering in the midst of these events.

Additionally, Niles et al. (2020) conducted interviews and ethnographic observations of program events, classes, presentations, and social groups at two engineering programs focusing on engagement with public welfare and emphasizing learning about the social context and social impacts. Niles et al. (2020) results reveal that the main areas where engineering students have trouble engaging with considerations of public welfare are (1) defining and defending their identities as engineers; (2) justifying the value of non-technical work and relevance to engineering; (3) redefining engineering expertise and integrating community knowledge into projects; and (4) addressing ambiguous questions and ethics. In contrast, as some narrators engaged in cross-cultural education groups, race-conscious groups, and action-oriented groups that center engagement, they did not question their engineering identity but instead questioned if their authenticity was able to fit within engineering.

Individuals with high-sustained development did not question their engineering identity but lacked a sense of belonging due to their social analysis within engineering spaces. Similarly, they valued non-technical work and its relevance to engineering; however, they were also aware that this value was devalued by engineering stakeholders and felt the need to suppress this interest. Most narrators did not discuss the need to redefine engineering. In contrast to Niles et al.'s finding, they discussed that community knowledge was necessary to engage in engineering work that involves any community at the interface. Furthermore, the ambiguity around addressing questions of injustices and ethics did not intimidate the engineers as Niles et al.'s findings present. Instead, the questions about injustices and their ambiguity were invigorating to

some narrators involved, and they desired for this to be a common element within their engineering classrooms. This is expressed in Richard's interview as he offers a critique of engineering courses and the ways they approach ethical considerations. In scene 3, Richard describes how engineering education can improve to integrate social elements into technical elements while also considering the social forces underlying how engineering design changes according to the communities involved. He continues to say instead of teaching separate courses for ethics, ethical components should be a part of every course.

These findings align with the literature that states it is not enough to reframe engineering as a socio-technical field. However, my study differs slightly by highlighting the bottom-up approach that impacts engineers throughout their training. Throughout Niles, Roundbari, and Contreras' (2020) critique, they advocated for specific engagement with "the social" to include political engagement and social justice throughout the engineering field. My study findings also agree from the perspective of the intrapersonal level. For instance, as the field of engineering is being reframed as a socio-technical field, it is not changing the way typical engineers perceive their work and professional identity. For instance, one narrator explained that even if they noticed wrongdoing, they cannot interfere due to the code of ethics. They stated that their understanding of their engineering professional obligations is that even if one is wronged, they are not able to enact their sense of agency because they must always think of the public good. As the field changes, to address the ideological pillars of disengagement, there is a need to encourage critical consciousness within engineers so they can potentially enact their own agency to remain socially aware, community-based, and politically engaged in the outputs of engineering work.

7.4 Utility of Critical Consciousness (LG3)

Contribution: My findings highlight the utility of critical consciousness development to enable some Black engineers to establish a sense of fulfillment in their engineering identity and engineering work.

My study findings highlight how critical consciousness is a critical need in the professional development of Black engineers. In the above sections, I have focused on demonstrating how critical consciousness can holistically help the engineering field. In this section, I discuss the need for critical consciousness for Black engineers to navigate their careers. As previously discussed in Chapter 2, the literature positions Black engineers' careers as examples of engineers integrating social justice into an engineering paradigm. My study expands this conversation in literature by identifying how some Black engineers discuss the critical need to incorporate social justice into their engineering paradigm in relation to their own empowerment.

My study aligns with the literature about the presence of equity ethics within some Black engineers. However, it differs slightly by highlighting the importance of self-empowerment in the face of racial battle fatigue. McGee & Bentley (2017) highlight how Black engineers are likely to develop a critical motivation called 'equity ethic.' They define equity ethic as "a principled concern for social justice and for the well-being of people who are suffering from various inequities" (p. 4). The equity ethic framework is grounded in research on STEM undergraduate students of color, doctoral students, and postdoctoral scholars (Garibay, 2018; McGee et al., 2016; Gibbs & Griffin, 2013). In addition, research on equity explores the relationship between doctoral engineering and computing students' experiences with social

suffering, equity ethic, and career interest (Naphan-Kingery et al.'s, 2019). The results revealed that students with a high equity ethic personally experienced or witnessed social suffering within and outside academia. The majority of the narrators in my study describe their experiences or witness social suffering and demonstrate a high level of critical consciousness. However, they also discuss the emergence of burnout and mental health challenges that suppressed their desires to act on equity ethics. This finding relates to racial battle fatigue. Racial battle fatigue is a term that describes the cumulative effects of experiencing racism and discrimination consistently (Cokley et al., 2020). This phenomenon can significantly impact academic and workplace performance and lead to feelings of isolation, burnout, and disengagement, which all narrators describe in my study. As engineers engage in work that addresses social inequities, they must also consider how to ensure they have personal resilience as they challenge systems around them.

Prior literature states that individuals with marginalized identities are motivated by the need to address social inequities in their paid careers or voluntary acts of service. My study contributes to this conversation by demonstrating how the needs of some Black engineers are multifaceted. McGee et al. (2020) highlight how some Black people consider their individual experiences as tied to the success of the entire race. From this perspective, if these Black engineers are aware of Black suffering, they will see themselves as successful as they lift their communities up. However, within the constraints of the engineering work narrative and limited engagement with social justice, some Black engineers with community-driven motivations would be left with limited opportunities for community success. This disappointment is expressed by Vee when she found herself needing safety from racial battle fatigue in scene 11. In this scene, Vee describes this cycle where she is motivated to address social inequities because

she has experienced and/or witnessed community harm. Then, her experience and witness of community harm also impact her personally. In response, she retreats due to her need for restoration. Then, she is impacted by her inaction in addressing social inequities. In this scenario, either result leads to a negative outcome. She overcame this by achieving a sense of fulfillment and purpose in life. As a result, this purpose increased interest, persistence, and representation in the field of engineering.

Prior literature states that, for some Black Americans, understanding social and political elements in society means a specific understanding of racial and cultural elements. My study contributes to this conversation by identifying how some narrators found Black empowerment along their engineering career journeys by integrating social justice into their engineering paradigm. Brookins's (1999) examination of liberation and community psychology from a Black-centered perspective reframes the general definition of empowerment so that it is specific to Black Americans' historical experiences. His review found two central themes in the empowerment construct: race consciousness and self-actualization. My study identified the role of race consciousness and self-actualization along with narrators' SPD development. For instance, as identified patterns in Chapters 5 and 6, I noted how narrators discussed racial discrimination, internalized oppression, participation in Black culture, race-conscious groups, and limited self-actualization as they navigated engineering spaces. These findings point to the need for safety and self-actualization as the primary needs for Black engineers persisting through engineering careers regardless of their SPD level.

7.5 Manifestation of SPD Overtime (LG4)

Contribution: My study advances the discussion of the manifestation of SPD within Black engineers by drawing connections to the influence of critical reflection on the interrelated and unpredictable relationship between political efficacy and critical action. In addition, the results highlight the importance of intersectionality in the ways privilege and oppression present themselves within individuals.

7.5.1 The Influence of Critical Consciousness on SPD Elements

My study findings highlight the prevalence of SPD elements along Black engineers' career journeys. As previously discussed in Chapter 2, the literature states that Jemal's (2018) theory of transformative consciousness helps conceptualize, operationalize, and describe SPD. My study advances the literature on SPD development by identifying the role of transformative consciousness through career journeys. Watts et al. (2011) discuss the role of critical consciousness in promoting positive youth development. They suggest that critical consciousness allows the youth to develop a sense of agency and empowerment, increasing civic engagement and positive social change. My study advances the understanding of critical consciousness and its development beyond constrained educational environments. Findings highlight the role of SPD in pushing against professional boundaries and its impact on self-actualization in engineering careers.

Prior literature states SPD is broken up into three components. My study contributes to this conversation by demonstrating how SPD manifests within professional engineers' career journeys. Scholars have conceptualized critical consciousness into three components: (1) critical reflection or engagement in critical analysis of inequality, (2) political efficacy (sometimes referred to as critical motivation) or perceived capacity to affect change, and (3) critical action in

activities intended to affect change (Heberle et al., 2020; Watts, Diemer, and Voight, 2011). However, as I began to analyze the narratives, I realized there is no clarity on these definitions and how they are expected to interact. My findings advance the discussion of these components by using the theory of transformative consciousness (Jemal, 2018) on career journeys.

Given the current literature about the components of critical consciousness, I expected to notice distinctive domains within the narratives of career journeys. However, the narrators discussed the interrelated connections between identity, environment, experience, and critical reflection in the storytelling format. Jemal's (2018) theory of transformative consciousness operationalizes SPD to include *awareness*, *behavior-response*, and *consequence* to account for components within critical consciousness. My study advances the understanding of these components by identifying that *awareness* relates to the critical reflection component, *consequence* relates to the political efficacy component, and critical action relates to the *behavior-response* component. However, these domains do not fully fit within these components.

For instance, the awareness domain refers to how narrators consider underlying social forces, but this definition does not account for how awareness could be transactional and passive. Furthermore, there were examples in my findings where narrators discussed passively becoming aware of systems of oppression through attending a presentation, engaging in dialogue, or reading literature. In these circumstances, they are not actively reflecting or analyzing the situation. Once they become aware of these underlying causes, they are accepted because it helps make sense of their identity, environment, and experiences. My findings provide evidence that identity, environment, and experience play a vital role in how most Black engineers engage in critical reflection, perceive their sense of agency, and participate in critical actions.

Furthermore, given the current literature about critical consciousness, I expected my narrators to distinguish their insights between critical reflection, political efficacy, and critical action (Heberle et al., 2020; Diemer et al., 2016; Watts, Diemer, and Voight, 2011). However, my findings present the dynamic nature of critical reflections on their positioning in society, authenticity in the engineering field, and their sense of agency to act within their constraints. Given the literature's clear distinctions, I anticipated that narrators would discuss these components separately and that they would grow individually within each domain. However, my study advances this topic by drawing connections to the influence of critical reflection on the interrelated and unpredictable relationship between political efficacy and critical action. As narrators reflected on their awareness, behavior, and consequences of oppressive systems, they did not cleanly interact with each other. Awareness, behavior, and consequences operated in various order, and their prevalence along the career journeys varied according to the individual and circumstances. For instance, in Khalil's career, he started his journey in the awareness domain, evaluated circumstances based on that awareness, and later engaged in action. Whereas, for Nina's career journey, consequences presented themselves first, followed by action, and then later became aware of social forces. One difference between Khalil and Nina's career narrative was being presented with the utility of critical consciousness to navigate the circumstances their life experience presented them with. In conclusion, the SPD process within the narrator's journey presented itself in non-linear, unpredictable ways.

7.5.2 The Influence of Intersectionality on SPD Pathways

My study aligns with literature that discusses the role of social identity in SPD; however, it differs slightly by highlighting the importance of intersectionality in the ways privilege and oppression present themselves overtime. Mcalister et al. (2020), utilized transformational

resistance and engineering identity to explore ways that engineering identity, social identity, and identification with social justice may be co-developed. In this study, they discovered that his experiences as a Black person caused him to have a personal connection to his critiques of social oppression, and he learned that he might have agency in working towards social justice through engineering. Even within the Black social identity focus of this study, there is diversity in gender, location, ethnicity, culture, religion, socioeconomic status, first-generational status, and other factors that we may not have been able to discuss specifically. The outcome of this diversity is the variety of ways the SPD pathways manifest within each individual.

Prior literature states that individuals' characteristics were significantly related to their level of SPD. My study contributes to this conversation by exploring how the manifestation of SPD within Black engineers' career journeys is identified within individuals of various characteristics. In a research study, Watts et al. (2003) used the Theory of Sociopolitical Development to explore the relationship between political attitudes and individual characteristics such as education, age, and gender. This study found that education level was the strongest predictor of sociopolitical development, with higher levels of education being associated with higher levels of sociopolitical development. Age and gender were also found to be significant predictors, with older individuals and women tending to have higher levels of sociopolitical development. Since all narrators in this study obtained a B.S. in civil engineering and a graduate-level degree at a predominantly white institution, the narrators were each at the same education level within similar environments. Age was not captured in this data, but my findings align with gender being a predictor for higher levels of SPD. However, it differs slightly by also highlighting the instances where women felt the need to suppress their SPD, whereas suppression did not come up for the men in this sample compared to women. This questions the role of

intersectionality within the manifestation of SPD in Black engineers' career journeys over time. In the next section, I will extend the discussion of intersectionality to conceptualizations around critical consciousness by situating these narratives within the Matrix of Domination.

7.6 Black Engineers SPD Situated in the Matrix of Domination

Contribution: The manifestations of SPD along Black engineers' career journey within my study extend the discussions about the Matrix of Domination by contextualizing how some individuals challenge and overcome inequities within larger systems that shape their experience.

7.6.1 Overview of the Matrix of Domination

My study aligns with recent literature about the Matrix of Domination. However, it differs slightly by highlighting the sense of agency that is necessary at multiple system levels for Black engineering to persist in engineering cultures. Patricia Hill Collins (2022) coined the concept of the Matrix of Domination to refer to the interconnected systems of oppression that exist. She describes these interconnected systems of oppression as a complex web of domination that impacts all individuals differently depending on their social identities. This literature aligns with Paulo Freire's initial conceptualizations of critical consciousness. Both Collins and Freire emphasize the importance of awareness of systems of oppression that are necessary to address inequities and oppression within society. My study contributes to this conversation by extending it to the engineering field as some engineers attempt to address exclusion and bias baked within engineering culture.

7.6.2 Incorporating Matrix of Domination in Critical Consciousness Framework

My study aligns with Paulo Freire's understanding of critical consciousness as it highlights the prevalence of high critical conscious levels demonstrated by individuals. However, it differs slightly by highlighting the importance of intersectionality. Freire (1973, 2000) believed that a critical understanding of social and economic inequities is a pre-condition for disadvantaged people to address inequities effectively. Individuals who displayed high-sustained development throughout their engineering careers were keenly aware of social and economic inequities and their root causes. For example, Khalil expressed his awareness of social and economic inequities that would exist in engineering culture before he enrolled in the institution and responded by cutting his hair to conform to the dominant engineering culture. prepared himself for it in scene 5. With his high awareness of the potential oppression that he would experience in engineering culture, he made decisions to assimilate in hopes that he could earn acceptance and opportunities. Individuals who demonstrated high-sustained development were also equipped to act within oppressive systems that alleviate society's social and economic injustice.

Conversely, individuals that displayed suppressed development were keenly aware of social and economic inequities; however, they were not fully equipped to act within the oppressive systems. Penguin describes an awareness of oppressive systems in the engineering workplace as she tries to decide the level of authenticity that she would be able to display in her engineering job search. She depicted academia as a cocoon and, as she prepared for transitions between school and work, she felt the need to suppress her Blackness and femininity. The distinction between awareness and social agency to act within these systems would benefit from incorporating an understanding of the Matrix of Domination.

7.6.3 The Impact of Matrix of Domination on Individuals' SPD

My study also advances Collins and Freire's theories about systems of oppression and our agency to address them by identifying the multiple levels at which systems of oppression impact individuals. For instance, Collins explains that the Matrix of Domination operates at both the individual and institutional levels, shaping personal experience and larger social structures. I advance the understanding of the multiple levels in which individuals experience the Matrix of Domination across multiple spaces within career journeys.

For example, at the intrapersonal level, Vee described her need to fight against internalized white supremacy by owning her Blackness and dismantling respectability politics. Respectability politics refers to the idea that marginalized individuals or groups must conform to mainstream or dominant cultural norms and values in order to gain social acceptance, equal treatment, and advancement in society. It is a set of behaviors, beliefs, and attitudes that are intended to distance oneself from negative stereotypes or perceptions of one's social identity. The internal work of addressing respectability politics is also agitated at the chronosystem level. For example, as Vee discussed the influence of massive Black murders across the nation that inhibited her ability to focus on her degree and influenced her decision to engage in literature centered on Black authors, thinkers, poets, and artists. Vee became empowered to confront the internalization of the dominant narrative surrounding Black living on multiple levels simultaneously. My study findings highlight that systems of oppression are experienced and witnessed by individuals at the intrapersonal, interpersonal, microsystem, mesosystem, exosystem, macrosystem, and chronosystem system levels which expands the understanding of the matrix of domination within individual and institutional levels.

7.7 Implications for Engineering Education

In the following sections, I will outline my dissertation's implications for practice, policy, and research. I will conclude my discussion of implications for research by suggesting directions for future research.

7.7.1 Engineering Education and Workforce Stakeholders

This research has several key implications for engineering stakeholders at the pre-college, undergraduate, graduate and workforce levels. First, the results of this study emphasize that Black engineers are not monolithic and have a diverse range of lived experiences and perceptions of their navigation through engineering structures. As engineering stakeholders consider broadening participation pathways it's essential to acknowledge that Black engineers have various motivations for entering the engineering field and barriers that push against their persistence. My finding highlights that there are experiences where most Black engineers are attempting to meaningfully contribute to engineering as they develop their engineering identity; however, these attempts are devalued, siloed, or ignored. For instance, Khalil was motivated to obtain an engineering degree because he desired to use the engineering skill set to address housing inequities. However, as he engaged in engineering spaces to apply equity framework, he was isolated and discouraged from making these contributions. On the other hand, Nina was motivated to obtain an engineering degree to gain financial upward mobility and had to work three jobs due to her inability to secure funding for her education. Then there is Vee who was motivated by the opportunity to contribute to something bigger than herself and was forced to make these contributions outside of her engineering work. These insights suggest that as we recruit diverse engineers into engineering, there must be transparency about the dominant

conceptualizations of engineering work and a presentation of opportunities for diverse pathways based on these motivations.

The career journeys also offer important implications for engineering programming in undergraduate and graduate spaces. As student's navigate engineering in a predominantly white space, there is a need for counter-spaces to process the dynamic emotions surrounding their experience, engage in critical dialogue that interrogates systems of oppression and participate in community-based activities. Each narrator discussed being burned out and/or disconnection from their sense of self as they navigated engineering space. Beyond counter-spaces offering a sense of belonging, there is a direct need for therapeutic practices that encourage transparency, listening and empowerment. In addition, individuals with higher SPD levels discussed the role of critical resources and dialogue that encouraged an analysis of contemporary society and their agency to act within systems of oppression. In contrast, individuals that failed to mention critical processing experienced internalized oppression. As harm is caused, there must be spaces for accountability and rehabilitation. Therefore, counter-spaces should not be siloed to only those impacted by oppression because this places the burden of responsibility on marginalized individuals or groups to change themselves in order to fit in, rather than challenging the systemic inequalities and prejudices that create and maintain those stereotypes and negative perceptions in the first place. There should be opportunities for all individuals to listen and engage with diverse experiences to promote community-based accountability.

Lastly, this study offers the need for diversity, equity, and inclusion considerations for the preparation of school-to-work transitions. As most Black narrators engaged with the workforce, they were challenged to suppress their authenticity and need for community engagement. For instance, Penguin expressed the need to suppress both her Blackness and femininity in order to

be open to multiple job opportunities. Similarly, Vee needed to be able to restore the harm caused in her navigation through engineering spaces and desired a job where she could focus on her family. Later in her career, she needed to obtain a professional engineering certification to gain respect for her perceptions of engineering work among the elitist engineering work culture. However, Khalil and Vee were able to align their engineering work contributions with the desired impact, but Penguin ends her narrative still searching for these opportunities. As diverse engineers prepare for the engineering workforce, there should be targeted discussions around the reality of the role identity and authenticity of both the job search and career navigation process.

7.7.2 Engineering Education Policy

This research has important implications for how engineering educators conceptualize and assess sociopolitical considerations. Black engineers' narratives about their career journeys reveal the multidimensional and dynamic nature of SPD that directly interrogates systems of oppression and social-technical dualism. Recognizing that SPD is multidimensional, engineering educators and accreditation agencies should be specific about their values and criteria of social considerations in engineering concepts, principles, ethics, and practices. In addition, these social considerations should incorporate diverse cultural identities' perspectives to understand systems of privilege and oppression. My findings point to the absence of social considerations in engineering work and how some Black engineers enact their own agency to bring in equity analysis of engineering work. In addition, the findings provide evidence of how equity and justice work is seen as invisible in engineering culture. However, if policies were to incorporate equity and justice work within their requirements or qualifications, engineering stakeholders could reimagine engineering spaces that are inclusive of all identities collaboratively.

7.6.3 Limitations and Avenues for Future Research

In the context of this dissertation, I applied Jamal's relatively new theory of Transformative Consciousness by only focusing on the domains, levels, and socio-ecosystem levels. However, this theory also took an analysis further by incorporating stages within each level. I asked each participant to reflect on these stages; however, throughout the participants' narratives, the stages were not central to the narrators' reflections on their journey as the theory initially implied. I have included quotes from their stages; however, I focus on the levels in the analysis to simplify the findings. Another limitation is that the sample focuses on engineers trained in civil engineering disciplines. These limitations provide avenues for future research.

The findings from this study provide a launchpad for future research that seeks to understand or measure sociopolitical development in engineers. First, there is work remaining to understand the definition and measurements of critical consciousness in professionals. Majority of the research, theories and questionnaires focus on youth development. Therefore, when searching for participants, I was limited in understanding how to measure participants critical consciousness to meet the criteria; however, I was able to lean on Jemal's (2018) Theory of Transformative Consciousness conceptual framework through the interviews. This study was exploratory in nature because Jamal's conceptual framework is a relatively new theory and limited research is available on its application and effectiveness. This model was presented as a quantitative measure of critical consciousness; however, more research is needed to quantitatively test the qualitative measures of my results. Furthermore, my results discuss the presence or absence of critical consciousness within various domains. However, within each domain of critical consciousness, I noticed that awareness, behaviors, and consequences were

more critical than others. There is a need to identify the spectrum of critical consciousness and how this spectrum varies within engineers.

To identify the spectrum of critical consciousness within engineering culture, the application of this theory needs to be extended beyond Black engineers to understand critical consciousness among other social identities and interrogate the intersectionality of critical consciousness. Furthermore, by focusing on marginalized communities, I have limited my understanding of consciousness around privilege. There is a need to understand the role that privilege plays in whiteness surrounding critical consciousness.

Lastly, we need to identify a method to measure critical consciousness in engineers that could also provide individualized recommendations for improvements in the future. The findings point to the various pathways through SPD and their critical incidents. As individuals become socially aware through various pathways, there is a need for targeted interventions that related to various practical life experiences.

7.8 Conclusion

I designed this multiple case narrative studies to explore the process of sociopolitical development within five Black engineers' narratives who are inspired to address social inequities through their engineering work. Using the Theory of Transformative Consciousness (Jemal, 2008), I explored five Black engineers' career journeys of incorporating social justice into engineering to understand sociopolitical development in engineers. This study finds that Black engineers describe multiple incidents within their childhood, education and careers influencing their awareness, behavior and perception of consequences that influence their SDP along their engineering career journey. This study highlights the influence of identity, culture, experience and environments SPD levels and domains. Furthermore, the findings situated SPD elements

within larger sociopolitical systems to highlight the interrelated nature of SPD within individuals as they navigate engineering structures. These results contribute to engineering education literature by (1) presenting a counter narrative of engineering work that accounts for perspectives of Black engineers, (2) highlighting the sense of agency that is necessary to integrate social justice element in engineering practice, (3) emphasizing the utility of critical consciousness development in establishing a sense of fulfillment in engineering identity, and (4) discussing the influence of critical reflection and social identities on political efficacy and action. Insights from this study compel engineering stakeholders to reflect on the ways engineering values perpetuate inequities in engineering pathways and engagement. The results advocate for a greater emphasis on sociopolitical development within engineering education as we theorize the future of the engineering field.

Ultimately, this research highlights opportunities to increase diversity in not only who becomes an engineer but how engineering is practiced in contemporary society. This study is based on the premise that education standards of success and the context that Black engineers are placed in environments that oppress and marginalize Black ways of existing as engineers. An anti-deficit approach to this study provided narratives of Black engineers that maintain their sense of self and express their identity throughout their careers to addressing social inequities. These stories will challenge dominant narratives about engineers' holistic disengagement with social justice and offer counter-narratives of Black engineers that desire to address social inequities through social agency and working for social change.

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Appendix

A.1 Appendix A: Invitation Email

SUBJECT: Eligibility to Participate in Dissertation Study on Black Engineers Incorporating Social Justice in Disaster Management Work

My name is Taylor Lightner, and I am a Ph.D. candidate in Engineering Education at Virginia Tech. For my dissertation, I am seeking to document narratives of Black engineers motivated to address social inequities through their engineering work in disaster/hazard management. **If you would like to participate in this study, please complete the [intake questionnaire](#) by Oct. 31, 2022. If you know someone that will be ideal for this study, please forward this email.**

For this study, disasters/hazards are defined as socially constructed events that result from the interface of nature, social conditions, and technology that further exacerbate social inequities. Environmental, health, and infrastructure disasters/hazards are of specific interest in the context of this study due to their disproportionate impacts on humanity. Disasters/hazards and inequities of interest include inadequate housing, poor access to nutrition, neighborhood segregation, community violence, lack of green space, toxic segregation, neglect of public services such as sanitation, and other health hazards and environmental factors disproportionately harming communities of color. For this study, I am interested in learning about the manifestations of critical consciousness that Black engineers exhibit throughout their careers in the disaster/hazard work space.

You are eligible to participate in this study if meet the following requirements:

- Identify as Black and/or African American
- Lived in the U.S. for over half of your life
- Earned a B.S. in any engineering discipline from an accredited university
- Worked on a project related to disasters (as defined above) in the past 5 years
- Worked in the U.S. context outside of academia for at least 2 years
- Display a tendency to identify and/or address social inequities (health, environmental, and/or infrastructure injustices)
- Willing to participate in an interview about your critical consciousness

Participation in this study includes two steps:

1. Complete a 10-minute [intake questionnaire](#) by Oct. 31, 2022
2. Participate in (2) 1.5-hour interviews via Zoom over the next 3 months

All participants who complete the two interviews will receive a \$100 gift card.

If you have any additional questions about this study, please contact me at taylorcl@vt.edu.

Thank you for considering this request.

Sincerely,
Taylor Lightner, PhD Candidate
Department of Engineering Education, Virginia Tech
Ph.D. Advisors: Dr. Walter Lee (walterl@vt.edu) & Dr. Jeremi London (jslondon@vt.edu)

A.1.2 Invitation Flyer

Invitation to Participate in Dissertation Study on Black Engineers Incorporating Social Justice in Disaster Management Work

Purpose:

The purpose of this study is to explore the process of sociopolitical development within Black engineers' narratives who are motivated to address social inequities through their engineering work

Who is eligible?

- Identify as Black and/or African American
- Lived in the U.S. for over half of your life
- Earned a B.S. in any engineering discipline from an accredited university
- Worked on a project related to disasters/hazards in the past 5 years
- Worked in the U.S. context outside of academia for at least 2 years

Participants will receive up to \$100

Interested?  Contact Taylor Lightner at taylorcl@vt.edu for more information

 Sign up for a quick 15-minute information session @ <https://tinyurl.com/BlackEngineerStudy>

A.2 Appendix B: Intake Survey Template

Purpose of Study: The purpose of this study is to explore the process of sociopolitical development within Black

engineers' narratives who are motivated to address social inequities through their engineering work. Purpose of Survey: This intake questionnaire is utilized to understand your sociopolitical development along with descriptive statistics surrounding your narrative. Thank you for taking the time to fill this out and I look forward to meeting you soon! Best, Taylor Lightner

Name

Please provide an email address so I can follow up with you for future correspondence. (Email addresses will be the only identifiable information requested if you would like to receive a reward for your participation and for further communication according to the needs of this research study. Email addresses will be kept separate from responses to this survey. If you are not selected, you will receive an email, and your contact information will be removed)

Please enter your self-identified pseudonym or alias you would like to be referred to as during this study. This name will be used so that you can remain unidentified. Please utilize this name for any other supplemental information that you might find useful for this study.

In this section, you will be asked questions about your current sociopolitical participation level. Please answer as honestly as possible, these individual responses will not be disseminated to a broader community.

Please select 1 statement that resonates the most with your current perception and/or behavior

1. I believe that the world is basically fair
2. I believe that the world is basically fair, but others believe that it is unfair
3. I believe that the world is unfair for only some people
4. I believe that the world is unfair, and I make sure to treat others that are historically treated poorly fairly

Please select 1 statement that resonates the most with your current perception and/or behavior

1. I believe that all people are treated equally
2. I believe that some people don't take advantage of opportunities given to them and blame others instead
3. I believe that some groups are discriminated against
4. I work to make sure that people are treated equally and are given equal chances

Please select 1 statement that resonates the most with your current perception and/or behavior

1. I think that education gives everyone an equal chance to do well
2. I think that education gives everyone who works hard an equal chance
3. I think that the education system is unequal
4. I think that the education system needs to be changed in order for everyone to have an equal chance

Please select 1 statement that resonates the most with your current perception and/or behavior

1. I believe people get what they deserve
2. I believe that some people are treated badly but there are ways that they can work to be treated fairly
3. I believe that some people are treated badly because of oppression
4. I feel angry that some people are treated badly because of oppression, and I often do something to change it

Please select 1 statement that resonates the most with your current perception and/or behavior

1. I think all social groups are respected
2. I think the social groups that are not respected have done things that lead people to think badly of them
3. I work to make sure that people are treated equally and are given equal chances
4. I am respectful of people in all social groups, and I speak up when others are not

Please select 1 statement that resonates the most with your current perception and/or behavior

1. I don't notice when people make prejudiced comments
2. I notice when people make prejudiced comments, but I am able to move on.
3. It hurts me when people make prejudiced comments, but I am able to move on
4. When someone makes a prejudiced comment, I tell them that what they said is hurtful

Please select 1 statement that resonates the most with your current perception and/or behavior

1. When people tell a joke that makes fun of a social group, I laugh and don't really think about it
2. When people tell a joke that makes fun of a social group, I laugh but also feel uncomfortable
3. When people tell a joke that makes fun of a social group, I realize that the joke is based on a stereotype
4. I tell people when I feel that their joke was offensive

Please select 1 statement that resonates the most with your current perception and/or behavior

1. I don't see much oppression in this country
2. I feel hopeless and overwhelmed when I think about oppression in this country
3. I feel like oppression in this country is less than in the past and will continue to change
4. I actively work to support organizations that help people who are oppressed

Please select 1 statement that resonates the most with your current perception and/or behavior

1. I don't feel bad when people say they have been oppressed
2. I feel sad or angry when experiencing or seeing oppression
3. I often become sad or angry when experiencing or seeing oppression, but I find ways to cope with my feelings
4. I work to protect myself from negative feeling when acts of oppression happen

Please read the following statements and indicate the extent to which you agree or disagree

| | 1 | 2 | 3 | 4 | 5 |
|---|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| I know there are ways that I can contribute to under-served communities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I am motivated to try to end racism and/or discrimination | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| It is important to fight against social and economic inequality | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| I can make a difference in under-served communities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| More effort is needed to end racism and/or discrimination | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| It is important to me to contribute to my community and/or diverse communities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| In the future, I will participate in activities or groups that work against racism and discrimination | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Please select as many statements as it applies to you:

1. I am involved in activities or groups that are against racism and/or discrimination
2. I am involved in activities or groups that promote equality and justice
3. I have participated in demonstrations or signed petitions about justice issues
4. I have found myself needing to separate these activities selected above from my day to day activities as an engineer

In this section, you will be asked questions surrounding you self-identification

What is the primary field of your engineering degree (B.S. Degree)?

1. Aeronautical Engineering
2. Aerospace Engineering
3. Space Engineering
4. Biochemical Engineering
5. Biological Engineering
6. Biomedical Engineering
7. Biosystems Engineering
8. Medical Engineering
9. Chemical Engineering
10. Architectural Engineering
11. Civil Engineering
12. Construction Engineering
13. Computer Science
14. Computing
15. Information Systems
16. Information Technology
17. Software Engineering
18. Communications Engineering
19. Computer Engineering
20. Electrical and Computer Engineering
21. Electrical Engineering
22. Electronics Engineering
23. Engineering Chemistry

24. Engineering Physics
25. Engineering Science
26. Engineering
27. Engineering, General
28. Engineering, Other
29. Environmental/Environmental Health Engineering
30. Forest Engineering
31. Geological/Geophysical Engineering
32. Naval Architecture and Marine Engineering
33. Ocean Engineering
34. Industrial Engineering
35. Manufacturing Engineering
36. Operations Research
37. Systems Engineering
38. Ceramic Sciences and Engineering
39. Materials Engineering
40. Metallurgical Engineering
41. Mining and Mineral Engineering
42. Paper Science and Engineering
43. Polymer/Plastics Engineering
44. Textile Sciences and Engineering
45. Automation Engineering
46. Electromechanical Engineering
47. Energy Systems Engineering
48. Engineering Mechanics
49. Mechanical Engineering
50. Mechatronics Engineering
51. Robotics Engineering
52. Surveying Engineering
53. Nuclear Engineering
54. Petroleum Engineering
55. Other

What university did you attend for your B.S. degree?

Have you lived in the U.S. for over half of your lifetime?

1. Yes
2. No

What is the highest level of formal schooling that you have completed?

1. Did not finish high school
2. High school graduate/GED
3. Vocational/technical certificate or diploma
4. Some college but did not receive a degree
5. Associate or other 2-year degree
6. Bachelor's or other 4-year degree
7. Master's degree (M.A., M.S., M.B.A. etc.)
8. Doctorate degree (Ph.D., J.D., M.D.)
9. Don't know

What is the highest level of formal schooling that either of your parents/guardians have completed?

1. Did not finish high school
2. High school graduate/GED
3. Vocational/technical certificate or diploma
4. Some college but did not receive a degree
5. Associate or other 2-year degree
6. Bachelor's or other 4-year degree
7. Master's degree (M.A., M.S., M.B.A. etc.)
8. Doctorate degree (Ph.D., J.D., M.D.)
9. Don't know

Do you identify as a member of the LGBTQ+ community?

1. Yes
2. No
3. I prefer not to answer

How would you describe your gender identity?

1. Woman
2. Man
3. Gender Non-binary
4. A gender not listed (please specify)
5. I prefer not to answer

Please indicate your race/ethnicity.

1. American Indian or Alaska Native
2. Black or African American
3. Hispanic or Latino
4. South Asian (e.g., Indian, Pakistani, Bangladeshi, Sri Lankan, etc.)
5. East Asian (e.g., Chinese, Korean, Japanese, etc.)
6. Southeast Asian (e.g., Thai, Vietnamese, Burmese, etc.)
7. Middle Eastern or North African
8. Native Hawaiian or other Pacific Islander
9. White
10. Another race/ethnicity not listed (please specify)

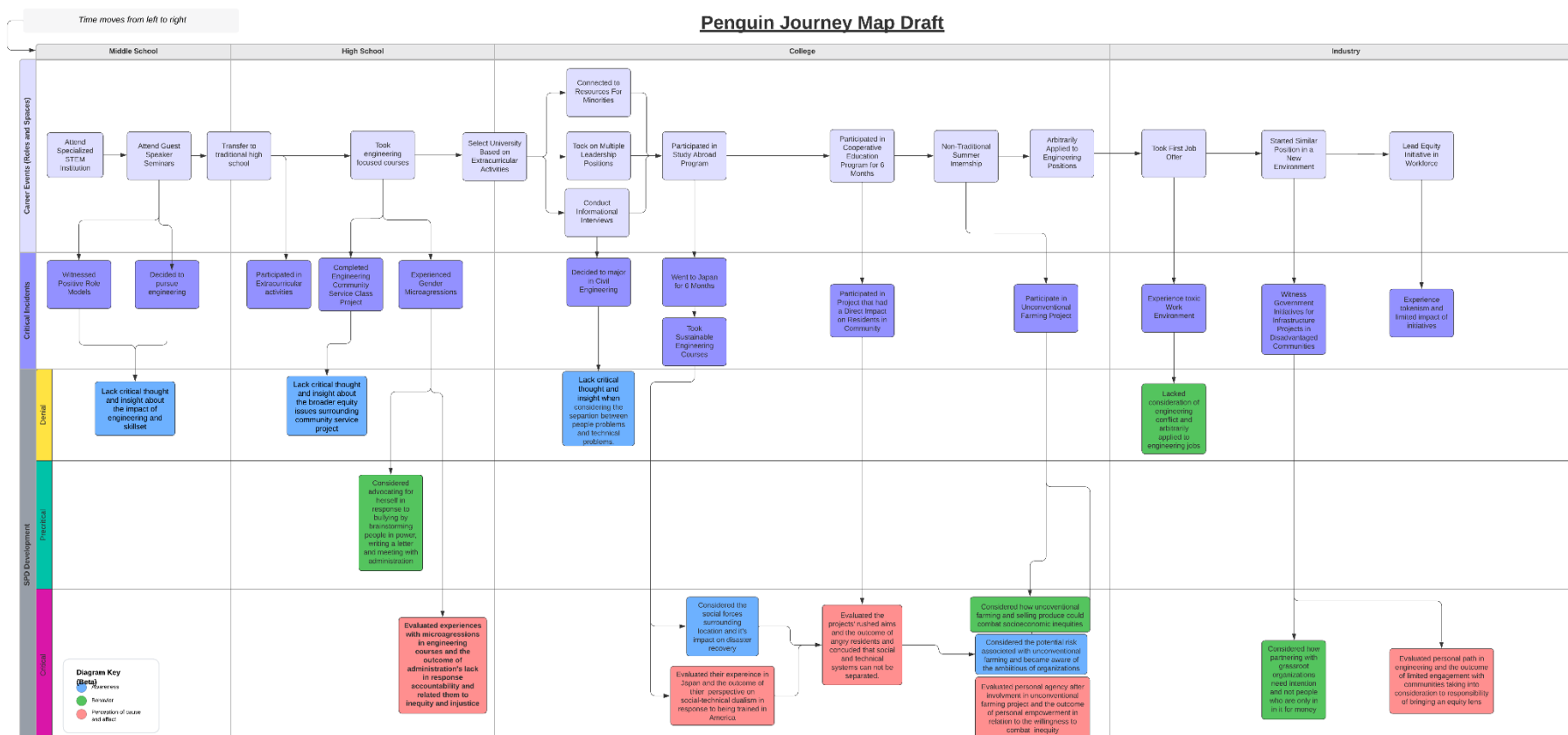
In this section, you will be asked open-ended questions surrounding your motivation to address social inequities through engineering work in disaster management.

When you consider your engineering work, what context does it take place in? (i.e., academia, industry, non-profit, government)

Please describe how your engineering work relates to disaster management and/or hazard mitigation? For this study, disasters are defined as socially constructed events that result from the interface of nature, social conditions, and technology that further exacerbate social inequities. Environmental, health, and infrastructure disasters are of specific interest in the context of this study due to their disproportionate impacts on humanity. Disasters and inequities of interest include inadequate housing, poor access to nutrition, neighborhood segregation, community violence, lack of green space, toxic segregation, neglect of public services such as sanitation, and other health hazards and environmental factors disproportionately harming communities of color. (N/A if it does not apply to you)

How long have you worked in this space?

A.3 Appendix C: SPD Draft Plot



A.4 Appendix D: Follow-up Interview Protocol

Interview Protocol




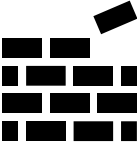
1. First, we will review your journey map draft from the first interview, and I will need you to provide feedback on events, critical incidents, and identified codes. As we review, please think about the interactions that made a direct influence on the following outputs.
 - a. Career Events: These events were considered memorable events in your initial interview alongside your engineering career journey
 - b. Critical Incidents: These events were considered memorable incidents that influence your critical consciousness
 - i. Critical consciousness refers to an individual's awareness of oppressive system forces and a sense of efficacy and engagement in action against oppression
 - c. Sociopolitical Development (SPD): Depicts your journey through critical consciousness. Currently, they are coded by levels and domains.
 - i. Levels:
 1. Denial: Does not consider the individual and social forces that shape people's lives or the identified problem (e.g. disaster mitigation)
 2. Precritical: Blames individuals for the exclusions of all other systemic factors or social forces for problems (e.g., disaster mitigation) and/or shape of people's lives
 3. Critical: Takes into consideration the individual and social forces that shape people's lives of the identified problem (e.g., disaster mitigation)
 - ii. Domains:
 1. Awareness: Reflection on the underlying causal factors or potential solutions
 2. Behavior: Consciousness of potential actions to challenge inequities within environments



3. Perception of cause and effect: A temporal aspect that helps reveal cause-and-effect relationships between social forces and social circumstances and the believed effect of inequities
2. Specific questions after analysis
 3. As I go through the analysis, I have a few questions for Vee,
 - a. Questions on Journey Map:
 - i. How long was the South Africa trip?
 - ii. Can you describe your work that is centered on Equity and Justice?
 - b. Questions about SPD Development:
 - i. In asking about your interest surrounding engineers, you mentioned the attraction of sustainability but then said at that point in your life, you had no experience with sustainability. What did you mean by that? (At 5:01) (Point back to in SPD Development Section)- Look more into this development in the SPD model
 - ii. She also said at 17:55 that she had done the research, and I wanted us to dive more into what this looked like. This may come out in the SPD-level interview.
 - iii. At 41:52, you mentioned you noticed a separation in South Africa. Could you describe the separation you recognized?
 4. Next, we will take the remaining time to reflect on your critical consciousness journey alone. We will review the table on stages in critical consciousness and reflect on your experience with each stage, considering how your motivation to address social inequities has been influenced by this journey. In your first interview, you discussed the following topics.
 - a. Sustainability
 - b. Activism
 - c. Self-Empowerment
 - d. Engineering for Environmental Justice

As you go through each stage can you also reflect on these topics

Table 1. Stages in Transformative Consciousness Development

| Level | Stage | Definition |
|-------|-------|------------|
|-------|-------|------------|

| | | |
|---|--|--|
| Level 1: Non-critical/denial | <p>Stage 1: Unconscious Belief</p>  | <p>The individual takes what they know as all-being, and beliefs are unconscious and automatic.</p> |
| | <p>Stage 2: Discovery</p>  | <p>The individual develops a consciousness of conflicting perspectives usually precipitated by confrontation or challenge.</p> |
| Level 2: Precritical blame/credit | <p>Stage 3: Duality</p>  | <p>The individual attempts to find ways to hold countering beliefs while struggling to maintain pre-existing beliefs in the face of contradicting information or experience.</p> |
| | <p>Stage 4: Contemplation</p>  | <p>The individual begins to recognize that their beliefs had a beginning and can also have an end.</p> |

| | | |
|---------------------------------------|---|---|
| Level 3: Critical consciousness | <p>Stage 5: Integration</p>  | <p>The individual develops an attitude of complacency regarding the conflict and asymmetry of consciousness. Individuals integrate new and old ways of thinking that inform action.</p> |
| | <p>Stage 6: Liberation</p>  | <p>Based on the integration of new and old ideas and micro and macro factors, the individual can discern the roots of their thinking and the factors influencing consciousness.</p> |

A.5 Appendix E: Sociopolitical System Codebook

| Socio-ecosystem Codes | Definition |
|------------------------------|--|
| Intrapersonal | Note when the narrator discuss internal processes that relate to the self; includes the process that exist only within a person (e.g., internal thoughts, attitudes, emotions and beliefs) |
| Interpersonal | Noted when narrators discuss interactions between them and another individual |
| Microsystem | Noted when narrators discuss interactions between groups of individuals closely related to an individual |
| Mesosystem | Noted when narrators discuss interactions between different parts of a their microsystem (e.g. family, education and workforce) in which the microsystem exert influence upon each other |

| | |
|--------------|--|
| Exosystem | Noted when narrators discuss interactions between institutions/engineering education department in which the individual plays no role in decision making process but it has a direct or indirect impact on the individual level |
| Macrosystem | Noted when narrators discuss sociopolitical environment, culture, norms, values, laws, attitudes, and ideologies. This includes when they discuss known aspects of an environment that cannot be related to an individual interaction. |
| Chronosystem | Noted when narrators discuss the patterning and cumulative effects of events and transitions manifesting overtime or through the individuals narrative along with socio-historical circumstances shape the individuals context |