Check for updates

Received: 29 July 2022 | Revised: 8 March 2024 | Accepted: 18 March 2024

DOI: 10.1002/jee.20595

JEE
Journal of Engineering Education

RESEARCH ARTICLE

# "I know what I need to learn": The intersection of aspirational and navigational capitals for marginalized-identity STEM students

**Erica B. Sausner** | **Cassandra Wentzel** | **James Pitarresi**

STEP and CSTEP, EOP, Department of Mechanical Engineering, Binghamton University, SUNY, Binghamton, New York, USA

**Correspondence**
Erica B. Sausner, Binghamton University, SUNY, Binghamton, NY, USA.
Email: esausner@binghamton.edu

**Funding information**
National Science Foundation, Grant/Award Number: 79207

## Abstract

**Background:** The community cultural wealth (CCW) theoretical framework recognizes the assets of oppressed communities. Within the framework, aspirational capital refers to the hope to achieve in the face of systemic barriers, while navigational capital includes tactics engaged to progress within institutions that were not designed for equitable achievement. This study explores where aspirational capital and navigational capital overlap (a frequent and theoretically relevant occurrence) for marginalized-identity (MI) STEM (science, technology, engineering, and mathematics) students.

**Purpose:** This study provides insight into the experiences of higher education for MI students. Understanding students' deployment of navigational and aspirational capitals can direct change within institutions.

**Design/Method:** This analysis draws on 51 semi-structured interviews with 26 participants. Multiple rounds of qualitative coding and shared meaning-making among authors support the present findings.

**Results:** When aspirational capital and navigational capital overlap in student experience, three themes emerge. First, MI students use individualized actions to meet their goals; their extreme self-reliance and engagement of priorities and milestones are key. Second, intrinsic motivators echoing meritocratic narratives encourage students. These narratives emphasize the value of hard work and taking advantage of opportunities. Finally, external forces, including institutionally based experts and culture, reflect aspirational and navigational capital engagement that support the individual's approaches and mindsets. Each finding includes nuance based on demographic categories.

**Conclusions:** MI students draw on aspirational and navigational capital for support in postsecondary education. Recognition of CCW components and strategies shifts the responsibility of equitable student experiences and academic success to institutions and stakeholders in STEM higher education.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.
© 2024 The Authors. *Journal of Engineering Education* published by Wiley Periodicals LLC on behalf of American Society for Engineering Education.

**KEYWORDS**

aspirational capital, community cultural wealth, marginalized-identity students, navigational capital, STEM

# 1 | INTRODUCTION

Although postsecondary student diversity is increasing overall, the low rate of diversity increases in STEM (science, technology, engineering, and mathematics) fields (National Center for Science and Engineering Statistics, 2021; Vespa et al., 2020) indicates the need to better understand marginalized-identity (MI) students in those fields. Postsecondary professionals who learn more about the experiences of MI STEM students are better positioned to serve students and change the institutional realities that foster exclusion. This analysis uses the community cultural wealth (CCW; Yosso, 2005) framework to understand the experiences of MI STEM students. The research question guiding this work is, "What approaches to engaging aspirational and navigational capital are salient for MI students in STEM higher education?" The findings reveal themes across student experience as they simultaneously deploy skills navigating the system of higher education and maintain hope in the face of challenges presented by that system.

# 2 | BACKGROUND LITERATURE

## 2.1 | Community cultural wealth framework

Yosso defined CCW as, "an array of knowledge, skills, abilities, and contacts possessed and utilized by Communities of Color to survive and resist macro and micro forms of oppression," (2005, p. 77). This framework was designed to present an asset-based understanding of the forms of capital that serve oppressed communities within the structures of White supremacy. Social, aspirational, navigational, familial, linguistic, and resistant capital were theorized as supportive of marginalized groups' experience, including in higher education (Yosso, 2005).

Occasionally, research has focused on a singular component of the CCW framework (i.e., aspirational, familial, navigational, or resistant capital) to understand student experience in STEM contexts (Denton & Borrego, 2021; Fernández et al., 2021; Listman & Dingus-Eason, 2018; Revelo & Baber, 2018; Sausner & Pitarresi, 2024). Such empirical focus has been rare, however, and has left many components of CCW understudied. More often, research has identified all components of CCW within a particular group of participants (see, e.g., Holland, 2017; Jaumot-Pascual et al., 2021; Pérez & Taylor, 2016; Samuelson & Litzler, 2016). Additionally, Latinx students in STEM has been a common combination of identity group and field of study for analysis (Monarrez et al., 2019; Morales-Chicas et al., 2022; Peralta et al., 2013). Where a group is studied alongside STEM, engaging the CCW framework, other areas of focus include pathways through STEM (Rincón et al., 2020), graduate school (Jaumot-Pascual et al., 2021; Pumaccahua & Rogers, 2022), engineering (Sellers et al., 2022; Tolbert Smith, 2022), and identity development (Ortiz et al., 2019). These framings—single components of CCW, all components of CCW, and a demographic identity group alongside CCW—have shaped broad understandings of CCW's role in postsecondary experiences for MI STEM students.

The overlap (or co-occurrence) of CCW components was suggested in theory (Yosso, 2005) and has featured in empirical work (Denton et al., 2020; Holland, 2017; Morales-Chicas et al., 2022; Rincón et al., 2020; Rodriguez et al., 2023; Sellers et al., 2022). Despite consistent representation, the co-occurrence of components has remained underexplored, including the overlap of aspirational and navigational capital, which has been indicated in a systematic literature review (Denton et al., 2020). Although the holistic exploration of this robust framework has continued, there is room to explore the overlaps as details of individual components are revealed.

## 2.2 | Aspirational capital

Aspirational capital has been defined as "the ability to maintain hopes and dreams for the future, even in the face of real and perceived barriers," (Yosso, 2005, p. 77). It has been linked to motivation and persistence in higher education and was indicated in 28 out of 33 studies in a systematic literature review of STEM education research that engaged the

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

CCW framework (Denton et al., 2020). Aspirational capital has also been discussed as a set of dispositions including goal orientation (Samuelson & Litzler, 2016). Where researchers have seen these traits (i.e., hope, dreams, motivation, persistence, and goal-oriented dispositions) associated with MI students pursuing postsecondary education, they have identified the presence of aspirational capital among their findings (Denton et al., 2020; Dika et al., 2015; Duncheon, 2018; Monarrez et al., 2019; O'Shea, 2016; Peralta et al., 2013; Samuelson & Litzler, 2016; Sausner & Pitarresi, 2024).

Aspirational capital has also been tied to its sources, including peer and community networks, which have contributed to success (i.e., persistence and the ability to serve others) in higher education (Pérez, 2014; Rincón & Rodriguez, 2020). In some cases, students' hope has related to feeling responsible to their communities (Espino, 2014; Ortiz et al., 2019; Peralta et al., 2013; Rincón & Rodriguez, 2020), emphasizing the cultural foundations of this component of CCW in addition to students' ties to their peers. Likewise, aspirational capital has been linked to students building on the encouragement of others (Espino, 2014; Holland, 2017; Miller & Bryan, 2020). Thus, research has revealed aspirational capital's ties to communities in its source (i.e., networks), in the motivations within the component, and its presence as an intrinsic trait.

Finally, aspirational capital has been found within processes or student experiences. For example, it has supported going to college (Liou et al., 2009). Throughout college, it has been linked to students' engineering self-efficacy (Dika et al., 2015) and to persistence, including through postgraduate education, for MI students (Espino, 2014; Liou et al., 2009; Peralta et al., 2013; Rincón & Rodriguez, 2020; Sausner & Pitarresi, 2024). One study of engineering undergraduates has identified aspirational capital as the most important component of CCW for underrepresented students who persist in higher education (Dika et al., 2018). These findings suggest that aspirational capital has helped shape MI students' postsecondary experience through the processes it has supported (i.e., enrollment, self-efficacy, and persistence). Although this body of literature has revealed broad categories of aspirational capital, there have not been studies exploring this component in conjunction with another component of the framework to explore how the traits, connections, and engagement in processes have supported students.

## 2.3 | Navigational capital

The second facet of this analysis, navigational capital, has been theorized as

> skills of maneuvering through social institutions. [...] For example, strategies to navigate through racially-hostile university campuses [drawing] on the concept of academic invulnerability, or students' ability to 'sustain high levels of achievement, despite the presence of stressful events and conditions that place them at risk.
>
> (Yosso, 2005, p. 80)

A systematic literature review of CCW in STEM fields has identified navigational capital in most studies (26 out of 33) (Denton et al., 2020). As with aspirational capital, this component of CCW has been displayed in terms of personality traits, including

> dedication, determination, creativity, independent thinking, academic confidence, a strong work ethic, and common sense. Common competencies included mathematical and analytical abilities, as well as the ability to learn things on one's own, manage one's time, build relationships with faculty, and ask questions.
>
> (Samuelson & Litzler, 2016, p. 104)

The presence of navigational capital has revealed students' recognition of when and how to draw on these intrinsic traits within institutions that were not designed for their success.

Navigational capital has also been empirically linked to social relationships and networks of peers (Pérez, 2014; Rincón & Rodriguez, 2020), school administrators (Pérez, 2014), and faith communities (Liou et al., 2009). Connections to those more knowledgeable about resources and college paths have supported MI students in moving around unspoken and nuanced expectations (Holland, 2017). Help-seeking and resilience have also been identified as representations of navigational capital (Duncheon, 2018). Recognizing the need for help and the networks through which it is

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

available have underscored the relevance of social ties for MI students' engagement of navigational capital in postsecondary education.

A small number of empirical works have focused on navigational capital independently. In Deaf student–mentor pairs, Listman and Dingus-Eason (2018) have linked the development of navigational capital to socialization by mentors, the development and promotion of self-advocacy, and networking within the scientific community. For Latinx engineering transfer students, navigational capital has been identified in their creation of opportunities, adjustment of habits, resource-seeking, and through their connections with social agents post transfer (Denton & Borrego, 2021). In these two populations, supportive communities or individuals have fostered the development of navigational capital (e.g., Deaf students' mentors and post-transfer social connections) as have students' independent actions managing their progress through higher education (e.g., self-advocacy or resource-seeking). These relationships between findings for Deaf students and Latinx engineering students have bolstered the understanding of navigational capital as network-based and reflective of student agency, and its alignment between demographics.

### 2.4 | CCW component overlaps

Although individual and collective components of CCW have been studied in multiple contexts, research has also identified components as they overlap. Yosso (2005) (in theorization) and others (in practice) have explained that components of CCW are not mutually exclusive; rather, they co-occur (see, e.g., familial and aspirational in Denton et al., 2020; Morales-Chicas et al., 2022; Rincón et al., 2020; Rodriguez et al., 2023; Sellers et al., 2022; social and navigational in Holland, 2017; and familial and navigational in Rodriguez et al., 2023). The logical and empirical connections between hope (i.e., aspirational capital) and action to support progress (i.e., navigational capital) have motivated the present study of these components' overlaps.

A systematic literature review has noted that "aspirational, navigational, and social capital were most frequently described as overlapping with one another and other types of capital" (Denton et al., 2020, p. 572). Among Latinx students, "participants all responded to academic difficulty with perseverance and savvy that embodied a combination of aspirational and navigational capital" (Duncheon, 2018, p. 367) and "[n]avigational capital intersected with aspirational, which served as an ongoing source of motivation" (Duncheon, 2018, p. 368). A study of Latinx engineering transfer students has revealed aspirational and navigational capital in their early submissions of applications for high-impact practices in pursuit of long-term engineering employment goals (Denton & Borrego, 2021). Motivation and action toward persistence in college have also been tied to the dispositional nature of aspirational capital and the skills-based nature of navigational capital as co-occurring components of the framework (Samuelson & Litzler, 2016). Although the overlap of these two components has been identified, it has yet to be explicitly explored as a focus separate from the CCW framework overall, or the independent components. The present analysis fills this gap by revealing themes within the overlap of the aspirational and navigational components of CCW.

## 3 | DATA AND METHODS

### 3.1 | Theoretical links: Data and analysis

This study's data collection centered on student experience, engaging the communities of practice framework. A community of practice (CoP) is one which was "created over time by the sustained pursuit of a shared enterprise" (Wenger, 1998, p. 45). During research design, STEM education and participation in a scholarship program were considered shared enterprises. The first author crafted semistructured interview protocols to investigate CoPs along these axes. Thus, while focusing on student experience, data collection was grounded in the CoP theoretical framework.

A previous study underscored the disparate experiences of MI students in STEM, evidenced by lower persistence for Black and Latina/o students compared to their White peers (Riegle-Crumb et al., 2019). Institutional inequity was revealed through exclusion and microaggressions faced by non-dominant communities in STEM (Campbell-Montalvo et al., 2021; McGee, 2018; Ong et al., 2018). For this analysis, CCW offered a supportive analytical framework that recognized "the array of cultural knowledge, skills, abilities and contacts possessed by socially marginalized groups" (Yosso, 2005, p. 69) to honor students' experiences. The philosophical foundation of CCW—critical race theory (CRT)—called attention to institutional inequities, as "CRT scholars also redefined racism as not the acts of individuals, but the

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

larger, systemic, structural conventions and customs that uphold and sustain oppressive group relationships, status, income, and educational attainment" (Taylor, 2016, p. 4). We recognized that for MI students the site of potential CoP-building (i.e., STEM postsecondary education) was steeped in White supremacy with persistent inequitable outcomes (Riegle-Crumb et al., 2019; Taylor, 2016). We chose an anti-deficit lens (i.e., CCW) to analyze student experience and interrupt the logic of White supremacy. The present work engaged the CCW framework for analysis of data centered on CoP to gain an asset-based understanding of MI STEM students' college experiences.

Choosing the term "marginalized-identity students" emphasized that alienation from STEM fields results from action. Moreover, "marginalized-identity students" aligned to the APA's (American Psychological Association's) guidelines for using inclusive language (Inclusive Language Guidelines, 2021).

## 3.2 | Study context

This analysis included a subset of data that was part of an ongoing study supported by the National Science Foundation (NSF). Two community colleges (CCs) and one 4-year institution (research-intensive, R1) implemented a scholarship program that featured a transfer pathway as part of the program design. The R1 was a predominantly White university in the northeast United States and the primary research site. While the scholarship program facilitated transfer from two CCs (and some participants followed these pathways), some participants transferred from other CCs and received support upon arrival to the R1.

All participants were members of a scholarship program that supported students from low socioeconomic status (SES) backgrounds pursuing college graduation. In combination with their racial, ethnic, and other identities, SES was a component of each student's intersectional identity. The participants studied chemistry, mechanical engineering, or physics (or related majors at the CCs) and most had a GPA above 3.0 on a 4-point scale. All participants received access to funding and supports including professional development, mentoring, and community building. Most of the scholarship supports were structured or provided by the first author; however, she was the second researcher to hold her position. As a result, interviews were conducted by two consecutive members of the research team.

## 3.3 | Data sources: Participants

The participants were a subset ($n = 26$) of members of the scholarship program outlined in the Study Context, and many ($n = 14$) were transfer students. Each participant was offered an opportunity to choose their own pseudonym that reflected their identities to be used in the present work. Although offered the opportunity to self-identify in terms of sex, no participants responded outside of the male ("M") and female ("F") binary. All participants were recruited and consented to participate through an IRB-approved process.

The sampling of participants, rooted in the theoretical foundations of CCW, included only students whose racial and ethnic identities are marginalized in STEM. Despite White female students' underrepresentation in STEM fields, we excluded students who identified "White" as their only racial or ethnic category. For example, a student who identified as "Black or African American" *and* "White" to represent a multi-racial identity was included in this sample, as were students who identified "Hispanic or Latino," and any racial category. The "do not wish to provide," and "Hispanic or Latino" options were features of the reporting designed by the scholarship funding agency, and the former was included in the "Race" and "Ethnicity" categories. Students who selected the "do not wish to provide" option in the "Race" category were included for analysis based on their ethnic self-identification as "Hispanic or Latino." Asian students were also included in the sample. This inclusion was supported by their intersectional identities, including their SES and racial identity as non-White. The experience of stereotype threat in STEM fields has been a source of stress for Asians due to the "model minority" myth (see, e.g., McGee, 2018). Participants' demographic information and their majors are included in Table 1 (including rows for White students because this was not a mutually exclusive identity).

## 3.4 | Methodology: Data collection and analysis

The primary source of data were 51 semistructured interviews with the participants ($n = 26$) indicated in Section 3.3. Some participants were interviewed multiple times with different foci in each interview (see below for protocol details).

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

**TABLE 1** Participant demographics and majors.

| Student demographics[a] | Physics (10) | Chemistry (9) | Mechanical engineering (7) |
|---|---|---|---|
| Male[b] | **7** | **5** | **5** |
| Black or African American | 2 | 1 | 3 |
| Hispanic or Latino | 2 | 2 | 1 |
| Not reported/do not wish to provide | 1 | 1 | 1 |
| Asian | 4 | 2 | 1 |
| White | 0 | 1 | 0 |
| Female[b] | **3** | **4** | **2** |
| Black or African American | 1 | 1 | 0 |
| Hispanic or Latino | 1 | 2 | 1 |
| Not reported/do not wish to provide | 1 | 0 | 0 |
| Asian | 1 | 2 | 1 |
| White | 0 | 1 | 1 |

[a]Racial and ethnic categories are not mutually exclusive.
[b]No double-counting.

Secondary sources of data included fieldnotes (seven by the first author) and student reflections on academic success and metacognition (eight participant submissions). The fieldnotes included first author's observations on participant interactions in nonformal settings including occasional shared lunches with students in the program.

Data collection took place between Fall 2018 and Spring 2020 semesters. Each recorded semistructured interview drew on one or two protocols that were created for this research, related to student experience and CoP (Wenger, 1998). They explored key features of CoP: identity, reification, and shared practice (Wenger, 1998). Protocol themes were applied according to students' program engagement, and themes included the transfer process; defining the field of the scholarship theme (a cross-disciplinary topic); communities, identity, belonging and practice; reflecting on progress and practice; and experience as a STEM student and a scholarship recipient. Although there were no follow-up interviews, some participants engaged in more than one interview that drew on separate protocols. Over the course of participants' enrollment in the scholarship program, the first researcher attempted to employ each of the five protocols at least once (except in the case of non-transfer students, who were not asked questions regarding the transfer process). Sample questions for each protocol can be found in Appendix A. The interviews lasted between 20 and 75 min, with the difference related to the number and length of protocols per session. Before analysis, interviews were transcribed verbatim.

Analysis for this work featured multiple rounds of coding by the first author, using MaxQDA (MaxQDA Analytics Pro, 2018), and sense-making between authors. The first author began coding based on a start list of (deductive) codes drawn from the literature on student experience and communities of practice (Wenger, 1998). This aligned to Krathwohl's point that, "[i]n preplanned studies, codes can be deductively derived from the goals of the study" (2009, p. 337). A second round of (inductive) codes was drawn from the data. Inductive codes reflected reasoning which, "involves extracting similarities in behavior or perceptions from the data and determining the important concepts and dimensions that underlie them." (Krathwohl, 2009, p. 337). Appendix B features codes listed by category. Next, theoretical winnowing of the data (Creswell, 2013) required evaluating all of the codes—following a deep understanding of the data—and identified codes that would likely align with the theoretical framework of CCW (Yosso, 2005). After isolating excerpts through this process, a final round of theoretical coding (Saldaña, 2013) used the components of community cultural wealth (Yosso, 2005).

The present findings were drawn from collaborative sense-making between the first two authors. Following multiple rounds of independent analysis and grouping of coded excerpts, the researchers met to discuss their conclusions. They identified categories and language to represent themes in the data through consensus-building conversation. Next, the authors disaggregated the data by demographic characteristics to identify nuance and further patterns, again engaging consensus-building around the results.

The strength of this study and its trustworthiness were supported by the research design, data collection, and data analysis processes. Lincoln and Guba (1985) suggested that the credibility of a study is bolstered by triangulation. The first author's repetition of the same semistructured interview protocols across participants allowed for the collection of

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

parallel data among participants. Commonalities among published research using the same analytical framework with related findings also bolster the credibility of this work. Credibility was further supported by the engagement of the second author in the analytical process. Coding was the first author's responsibility, as is often the case (Saldaña, 2013). However, shared meaning-making from coded data identified findings themes and represented the triangulation of investigators (Lincoln & Guba, 1985).

### 3.5 | Author positionality

The first author was responsible for most data collection, leading analysis, and manuscript preparation and edits. She identifies as a cis-gendered, heterosexual White American woman who is a first-generation college student. Her social position including her race, education level, and employment status impacted the data collection for this work due to the "researcher as key instrument" practice in qualitative inquiry (Creswell, 2013). The power distance created by the author's identity and her role administering a grant program that serves participants likely impacted their participation. The second author, who contributed to analysis and the preparation of this manuscript, identifies as first-generation, low-income, cis-gendered, heterosexual, biracial American woman. This position and its privileges impact this work and the perspective under which it is analyzed. Her continued work with higher education supports her understanding of institutional procedures. The third author, who supported this work through manuscript review, identifies as a White, cis-gendered heterosexual man.

### 3.6 | Limitations

The findings in this study are not generalizable beyond this sample of MI STEM students who were affiliated with this scholarship program due, in part, to small numbers within each demographic subgroup. This limiting component is based in recruitment for the scholarship program and the sampling procedure. Relatedly, we did not include participant ages. This represents a limitation given the engagement of transfer students who may fall outside of the traditional range of college students' age. Our data do not include ethnographic or detailed narrative analysis tools that are best used for speaking to in-depth specifics based on identities. Future research can improve upon these weaknesses by expanding participation and narrowing the focus of study (e.g., by demographic feature, transfer status, or discipline).

The broad inclusion of diverse participants poses a risk of homogenizing the participants under the umbrella of "marginalized-identity STEM students." Where possible, we included relevant sub-themes by demographic group to support the depth of each finding theme and recognize participants' diverse experiences. In the case of some groups, we do not have examples of their interview responses reflecting an overlap between navigational and aspirational capital within a finding theme. The structure of data collection—interviews with multiple protocols—is likely the cause of this data limitation (i.e., all interview protocols may not feature the prompts that led to participants discussing these capitals). Likewise, studying STEM students without distinction by discipline is a methodological choice that leaves room for further analysis. Without this distinction, the present work likely misses discipline-based nuance that shapes student experience.

Finally, researcher positionality is a limitation of qualitative work. The researcher is the "key instrument" of the empirical study (Creswell, 2013), and is shaped by their own experiences. Salient in this research are the differences between the first author and the participants. Bracketing throughout the research process, collaborative analysis with the second author, alignment with previous research, and triangulation within and beyond demographic categories support validity and reliability, as is common in qualitative work.

## 4 | FINDINGS

Across demographic groups, when aspirational and navigational capital co-occurred, students' experiences aligned under the categories of Individualization, Intrinsic Motivators, and External Factors. In the Individualization category of findings, the overlap of aspirational and navigational capital was reflected in student actions. The components were also seen in participants' mindsets, as displayed in the Intrinsic Motivators category of findings. Finally, when the components revealed ties to individuals or social constructs beyond participants, they were grouped in the External Factors

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

**TABLE 2** Findings: Themes and subthemes.

| Category | Sub-theme |
|---|---|
| Individualization (action) | Extreme self-reliance |
| | Prioritization and milestones |
| Intrinsic motivators (mindsets) | Hard work = success |
| | Every opportunity is essential |
| External factors | External sources as guides |

category. Two categories of findings featured sub-themes (see Table 2), and all findings included distinctions among demographic groups. In many cases, the nuance between groups was very subtle but consideration of these nuances highlighted participants' identities.

## 4.1 | Individualization

### 4.1.1 | Extreme self-reliance

Participants' high goals led them to extreme self-reliance. They felt confident and empowered to pursue their goals actively and independently. This sentiment reflected their aspirational capital, while the resultant actions revealed navigational capital.

Female participants from two groups, those who identified as Black and those who did not indicate their racial identities, engaged diverse skills and tools in navigating toward their goals. For Hispanic or Latino and Black female participants, self-reflection and identifying what they needed to meet their goals was key. When asked about critical moments that impacted her academic experience, for example, Andrea drew on tactics learned in her family: "It's kind of just separating my academic life from my personal life. I always find time to still study. Just growing up, my family doesn't really let emotions affect work ethic." (F, Black or African American, Hispanic or Latino; Chemistry major). Andrea's reference to "work ethic" and the attendant personal responsibility reflected self-reliance rooted in her family experience. She referenced a desire for academic success (i.e., good grades and understanding implied by studying) and tactics to get there (i.e., finding time and compartmentalization). This engagement of culturally developed tactics, common among Hispanic or Latino and Black female participants, shared commonalities with other identity groups.

Asian male participants' self-reliance was crucial for intentionally building their skillset to be applicable in diverse academic contexts including through research that enhanced their college experience. This pattern reflected aspirational capital in their interest in high-impact practices to support learning, as well as the navigational capital to seek out and engage with faculty. For Asian female participants, self-reliance included building trust in themselves and their decisions about seeking support. This was evident, for example, in the process of choosing colleges, transferring, class registration, and other components of their postsecondary experience. Asian female participants were comfortable finding information on their own and acting in their own best interests. Identifying decision points reflected aspirational capital as they indicated moving toward a goal, while the approach of self-reliance on finding relevant information and options (or pursuing help) were examples of independent navigational capital in pursuit of those goals.

Miguel (M, "do not wish to provide" race, Hispanic or Latino; Physics major) provided an example of deploying self-reliance through adaptation (a common tactic for Hispanic or Latino male participants) for building his academic expertise. When asked whether he would raise his hand to ask for clarification if he did not understand something in class, he said: "I would not. [...] I feel like it would be slowing the whole thing down. [...] I'm more of a self-teacher I've noticed. I like doing problems hands on. That's how I do my learning." He identified his ability to teach himself—a skill that may have developed from multiple lecture-style course experiences where questions were not invited, as indicated by his sense that his questions would "slow things down." At another point, Miguel indicated, "A lot of these times, the teachers just ramble on, and it's more the listening," emphasizing that the lecture style of one-way communication was prominent and related to his development of academic self-reliance. His approach of self-instruction was an adaptation and representation of navigational capital. Mouse (M, Black or African American, not Hispanic or Latino; Physics major) had a similar experience and said: "If I don't know what's going on, I don't speak. I can get it on my

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

own. I just have to put the time in. [...] Usually I'm caught up by the weekend and then I get lost again during the week, then I catch up on a weekend." Within this theme, perseverance was also salient for Black male participants and displayed through persistent effort, which is also partially reflected in Mouse's pattern of "catch up" for content understanding. The aspirational capital that pushed Miguel and Mouse toward course-based success overlapped with the navigational capital that highlighted their capacity for creating success through independent learning.

Participants presented shared perspectives on independence and self-reliance for success in college. Their determination represented aspirational capital while they drew on diverse tactics (such as independent decision making and self-instruction) to navigate toward that success.

### 4.1.2 | Prioritization and milestones

Participants engaged two actions, namely milestone development and prioritization, to support achieving their goals. Milestones were a point in time and progress that showed the direction of a goal. Prioritization indicated the presence of multiple goals (aspirational capital) and was also a tactic for approaching those goals (navigational capital).

Hispanic or Latino female participants utilized goal-setting as a tool for success. Julia, for example, carefully considered challenges between her experience and her long-term goals. She recognized immediate and longer term priorities and their impact on her future, reflecting aspirational capital. When asked about her goals for the academic year, Julia said:

> Getting my GPA up definitely. [...] I learn in my classes, but I feel like too late sometimes. When you grasp the concepts too late. I'm really focusing right now that it's beginning but getting to the first midterm point. [...] But yeah, I feel like getting my GPA up is the priority, aside from this because I need this scholarship and I like the program but also because I want to have above a 3.0 for next recruiting season because that's really, not the cutoff, but for looking for jobs that's like, if you're above 3.0 you're okay.
>
> (F, White, Hispanic or Latino; Mechanical Engineering major)

Julia recognized that she needed to navigate higher education and the labor market, with achieving a job as her goal. The 3.0 GPA was a milestone to inform her progress, while in-depth learning was an immediate priority.

Reflecting on goals led female participants who did not report their race and Black male participants to prioritize among their options in education. Black male participants prioritized their work and left less important things behind to keep on the path of academic success. Mathew, aware of his goals, identified his preference for a balanced course load and discussed prioritization in terms of "sacrifices":

> Sacrifices have to be made, so I have to do what I have to do [...] so I just throw [courses] in [my schedule]. You know, certain semesters come out how you want it to be, and certain semesters are like, yeah, those are one of those I have to put in the extra effort.
>
> (M, Black or African American, not Hispanic or Latino; Mechanical Engineering major)

This was like the approach of female participants who did not report their race, a group that stopped to consider all routes to success not just those most readily available. Likewise, Asian female participants stopped to evaluate before they moved forward to avoid issues or resolve them. In each demographic group, goal-setting was representative of the intersections of aspirational capital and navigational capital because it reflected hope for the goal and action toward achieving it through varied processes.

One Asian student offered examples of individualized milestones and prioritization tactics when discussing his research engagement. First, when asked about what he was proud of, Kyle (M, Asian, not Hispanic or Latino; Physics major) stated, "I got into the research group with ... actually [I] started first semester of sophomore year. That's pretty early." He identified academic standing (sophomore year) and research engagement goals as milestones. In a further conversation about research, Kyle discussed his priorities:

> So, I'm going to stay here for the summer. [...], they gave a $3,000 stipend, so that's why I joined the program. [...] Because they're basically the same thing, but they're both doing researching solar cells, but more is like more physics part of it. One that is more chemistry part of it.

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Kyle prioritized finding a research opportunity that would cover his summer living expenses on campus, which required him to consider options slightly different from his primary research engagement. From his first indication of research involvement through his prioritization process for summer, Kyle underscored his agency and individualization. Involvement with intentionality ("I got into the research group") and finding a funded opportunity to continue it, although with discipline variation, reflected navigation of the higher education system.

Hispanic or Latino male participants' milestones often related to self-improvement. David reflected on processes to better himself over time:

> Fall of 2019 was my second-best academic GPA in college. So, I'm very proud of that. Very proud of the fact that I was able to get myself on a schedule, a strict schedule, and I was able to excel in track as well. So, everything was going well.
>
> (M, "do not wish to provide" race, Hispanic or Latino; Mechanical Engineering major)

Like other Hispanic or Latino male participants, David expressed ongoing expectations of self-improvement in multiple areas of his postsecondary experience. His aspirational capital, evidenced by his success related to academics and student athlete engagement, was marked in time, ranked by GPA, and reflected milestones for his college experience. The individualized, self-imposed "strict schedule" was a tool to navigate those challenges.

Across demographic groups, students' engagement of prioritization and milestones were driving factors. Each reflected the overlap of aspirational and navigational capital in that they indicate a goal and actions taken to achieve it.

## 4.2 | Intrinsic motivators

### 4.2.1 | Hard work = success

Participants held a firm belief that success was attainable, if only they invested enough effort. This finding revealed aspirational capital in the desire for "success," alongside navigational capital, represented through "hard work," although the definitions of "success" and "hard work" showed great variation.

Black male participants worked diligently to engage self-reflection and identify when their work was hard enough. As indicated by Shawn (M, Black or African American, not Hispanic or Latino; Chemistry major), the idea of working hard was not a sufficient measure. His level of work was only adequate when it achieved success on par with that of a peer role model. He described: "I haven't had the results that he's had. [...] I mean, you can work hard, but if you don't get the results then it doesn't really matter." He and other Black male participants sought novel approaches and consistent hard work, representations of navigational capital, to build their success. Among their efforts were time management, varied study approaches, and seeking experiences outside of their comfort zone to achieve academic success.

Similarly, for Black female participants the idea of working hard and persisting was a point of pride, as indicated by Sofia:

> I'm proud of the fact that sometimes I would get like a test grade or some kind of response that wasn't, that I didn't really like, that felt a little bit discouraging. And I would get sad about it, and it would like ... I would beat myself up about it a little bit. But I was never like, "Okay, I'm done, I'm giving up." I was always like, "Okay, tell 'em to keep going. Maybe hit it a little harder. Try different things." So, I'm really glad that I was like that.
>
> (F, Black or African American, Hispanic or Latino; Physics major)

Sophia identified, with pride, her resilience and motivational self-talk. Where she suggested she would "hit it a little harder," she connected hard work (navigational capital) with her goal and "keep going" attitude (aspirational capital). Other Hispanic or Latino female participants also identified hard work as the path to success through a similar route. For Hispanic or Latino male participants, the connections between hard work and success were subtle and implied throughout the dataset.

Although Asian male participants' definitions of success often shifted, the foundation of hard work remained. Nazmus, for example, revealed confidence in his intrinsic motivation and ongoing hard work:

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

> To get any sort of high achievement, you have to put in work towards that achievement. I feel like that is what I excel at. The reason I feel like I am able to learn so much from my research is because I'm driven to do it. I'm driven by myself to do it. [...] I'm really good at that. I know what I need to learn. I can go on that Wikipedia page, and there would be, okay, so for this formula, you plug in this, this, and this. Then, I don't know what this is. So, I go to the next Wikipedia page, and I read about that. I don't know what something else is, so now I go back to the scientific paper that I was reading, and I look on the next page. Oh, look, it explains it right here.
>
> (M, Asian, not Hispanic or Latino; Chemistry major)

Nazmus indicated a combination of metacognitive skills (searching for answers) and individual effort (hard work; navigational capital) as highlights of his experience. His persistence of tracking down "what I need to learn," revealed a multi-step process driven by intrinsic motivation. Manifestations of hard work among Asian males, including the engagement of independent learning and intrinsic motivation (navigational capital tactics), drove participants to feel assured of their success.

Most of the Asian female participants spoke to the specific ways that their hard work built on past experiences. They engaged reflexivity to propel themselves, as indicated by Feng:

> I feel like my work ethic's a lot better. I'm trying to stay on top of my work. [...] Better than when I first started college. [...] I barely studied. That's really bad. But I wasn't really motivated. I was confused where I was, I was like, "Oh, I don't know what I'm going to do." But now I kind of ... this [mechanical] engineering is what I want to do.
>
> (Feng; F, Asian, not Hispanic or Latino; Mechanical Engineering major)

Like other Asian female participants, Feng indicated the engagement of work as preparation for her future. She emphasized her development and understanding of her own goals and interests (aspirational capital) and her work ethic as the approach to achieving it (navigational capital). Nazmus, Feng, and other students identified their weaknesses and addressed them by drawing on intrinsic motivators and dedication to working toward success. These approaches embodied navigational and aspirational capitals as parts of their higher education experiences.

Through an intrinsic drive to engage hard work in varied representations, students displayed confidence that supported their progress. The motivation reflected aspirational capital, while varied approaches to hard work reflected the engagement of navigational capital. The following finding suggests yet another internal refrain that propelled students forward.

### 4.2.2 | Every opportunity is essential

MI STEM students continuously pursued opportunities, even if they did not align with their specific goals or plan, because each opportunity offered improved chances for success. In some cases, taking advantage of opportunities shifted students' goals and directions. Seeking and engaging opportunities reflected their navigation through an unbalanced playing field, and their persistence indicated aspirational capital.

Exploration was key for Hispanic or Latino female participants who sought diverse knowledge to make choices around their future. Gisela, for example, discussed a component of her major choice that countered her personal preferences:

> I don't enjoy lab. That's the only part that I really dislike about chemistry. That's not what I want to do. I like the concepts. [...] But, my microbiology professor, she mentioned biofields like bacteria. [...] There's a really interesting relationship between microbiology and chemistry. So that's something that I'm really interested in, mixing the knowledge for chemistry and biology.
>
> (F, "do not wish to provide" race, Hispanic or Latino; Chemistry major)

Before she graduated, Gisela was an active participant in chemistry and biochemistry research. Despite her aversions, she took on research (beyond the scope of her major and within her major) that was not appealing to her to find the best way forward. These research opportunities expanded her pathways and professional networks toward graduation

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

and beyond. This example revealed her navigational capital in efforts to engage with multiple research opportunities so that she could find a way to make her major fit her interests, supporting her persistence and educational goals.

Black female participants also displayed intrinsic motivation through self-reliance and persistence (navigational capital) in pursuit of opportunities (aspirational capital). Andrea (F, Black or African American, Hispanic or Latino; Chemistry major) highlighted this drive, saying, "Because in my head, there is a thing to keep trying, but there's always opportunities. So why keep setting myself up for failure for the other one, and not go off for the good one by just keep trying?" Andrea acknowledged multiple avenues for success in meeting her goal of a summer research engagement. As Gisela and Andrea displayed, MI students drew on their intrinsic motivation to pursue various opportunities, even if they crafted a circuitous path forward.

Black and Hispanic or Latino male participants often changed majors to adapt to available opportunities. Gabriel discussed his reasoning for changing majors to enroll in a scholarship program:

> You're supposed to do three years at [the HBCU] studying mainly physics and heavy calculus math. And then you were supposed to transfer out to an engineering school of your choice, and if you do that's where you get to focus, whether it be mechanical, electrical. And at the time, I was electrical. But, when I transferred over to [the R1], I had to switch to [mechanical engineering] to get the [scholarship]. So, the main reason was that I [changed majors], because of the program asked that I did that.
>
> (M, Black or African American, not Hispanic or Latino; Mechanical Engineering major)

For Gabriel, prioritizing financial support combined with the opportunity to transfer for his dual degree but led him away from a primary goal (i.e., electrical engineering) toward a related opportunity. The pursuit of opportunity revealed an intrinsic motivation to achieve with flexibility around the details. The flexibility in tactics represented navigational and aspirational capitals as it allowed for persistence toward his goals.

For Asian participants (male and female), the pursuit of opportunities had ties to specific aspirations. Asian males' career focus motivated them to craft their academic selves and pursuit of opportunities. Asian female participants drew on their opportunities by identifying resources that would benefit their goals. Rather than changing tacks to find new opportunities, they sought individuals and experiences to support their approach to academic success and advancement.

Across demographic categories, participants reflected intrinsic motivation for opportunities and approached their goals through "hard work." They engaged flexibility around their goals as a tactic for making the most of what was available to them.

## 4.3 | External factors: External sources as guides

Participants searched for and accepted guidance, revealing their roles as novices in higher education. These experiences reflected goals and an acknowledgement of support (a navigational tactic) in reaching them. Interestingly, however, we did not find this pattern present in the experiences of Black male participants. Instead, Black male participants absorbed the responsibility of success.

Black and Hispanic or Latino female participants often drew on key figures to guide them through higher education and acknowledged extrinsic realities that informed their decisions. These guiding individuals were tied to their institution, either faculty or peers with more experience (e.g., teaching assistants). The external pressure of GPA was a further guide for Black and Hispanic or Latino female participants. GPA represented a clear path to employment and thus served as a guidepost for success. Other external realities also helped drive decision making for these students. When asked why she was attending the R1, Andrea, a Black, Hispanic or Latino female participant (Chemistry major) responded, "Reputation, and I visited before. [...] ... so, I was like, 'Okay, I would like to study here'. I chose it also because it was one of the cheaper options." For Andrea and other Black and Hispanic or Latino female participants, external forces (e.g., reputation, GPA expectations) informed their understanding of the values of higher education and how to navigate within them.

Hispanic or Latino male participants looked to the values and expertise of their family members and campus resources. Family members offered guidance in the form of shared values, especially around education. Campus-based external supports, however, offered additional motivation. Jesús, for example, was a returning student who began at a

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

CC before transferring the R1. Throughout his interview he identified a faculty member who was a motivator and a guide:

> I came back to school on a whim. On just like, "let me try this again." [...] But once I came back to [the CC], and I saw how, I want to say easy, but more focused I was. I saw that it's something I'm able to do. And then especially with [my professor] acknowledging me as a student, and as like the effort I was putting in, it made me more motivated to graduate [the CC] and attend a four year after.
>
> (M, White, Hispanic or Latino; Chemistry major)

In addition to motivation for graduation, at another point in his interview Jesús credited the same professor with guiding him to choose a major that suited his interests. Another facet of external influence for Hispanic or Latino male participants included their backgrounds, including "home" countries (those from which their families emigrated, although the participants were all US residents) and communities to which they wanted to contribute through their career or success. In service to these goals, their pursuit of content understanding reflected aspirational capital, as did their intent to contribute to their communities. Meanwhile, engaging with external sources of values and expertise displayed navigational capital in their willingness to learn from others and draw on community guidance.

For Asian male participants, campus groups and faculty members were sources of guidance, although often as a last resort in response to unspoken expectations. In one example, Lei discussed a class in which he started out strong but struggled near the middle of the semester:

> After [the] midterm, everything is getting harder. I feel it's overwhelming. I did talk with my professor. He said, "You may need to take more time." I said, "I do take more time only ..." Yeah, [I] struggled with that thing.
>
> (M, Asian, not Hispanic or Latino; Chemistry major)

Later in the interview, responding to a prompt about improving academically, Lei discussed his effort compared with external expectations. Asked if he tried his best, he responded: "Maybe just that's just what I thought. [...] Maybe in professor's eyes, you can do better." His perspective reflected the deference he granted to his instructor for defining meaningful effort. Lei's outreach to faculty showed his engagement of navigational capital toward his goal, and aspirational capital in the presence of this goal (academic success). Accessing campus groups' influence was another navigational tactic that Asian male participants engaged to support their goals. In the example below, Rashid discussed the benefits of culturally relevant networking opportunities. The "air" at the National Society for Black Engineers (NSBE) conference offered better connections to help determine his next career steps:

> I really feel like in a career fair, like the one at NSBE ... I don't know, it was just ... the air was different, do you know what I mean? It felt like the people there really wanted you to succeed. [...] The career fair at [the University], I don't know if it made me feel a bit unmotivated. [...] But, but in the actual career fair [NSBE] had in Detroit, members were ... sometimes the people from the different fairs actually came up to us and they were like, "Hey, are you interested in our sector? We have some available openings here and here. Can I get your resume? I want to see what your qualifications are."
>
> (M, Asian, not Hispanic or Latino; Mechanical Engineering major)

The complexities of this example revealed the overlap of aspirational and navigational capital and the ways that Rashid linked decisions about his future to external settings that fostered his belonging. At another point in the interview he stated, "I felt like I belonged more in there, even though it's not really where I'm culturally represented." He joined a Black student organization which signaled that he craved community and that another MI group was the best place for him to obtain that sense outside of the traditionally individualistic experience of college. Lei and Rashid provided contrasting examples of how Asian males sought external expertise and resources to support their goals, either through group engagement or seeking other guidance on campus. Despite the differences in experts, the strategy of reaching out (navigational capital) reflected their dedication to success in the face of their academic, social, and professional challenges (aspirational capital).

Finally, female Asian participants also turned to outside expertise, including faculty, as they navigated their academic path. Lydia reviewed the varied guidance she sought:

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

> I went to [the professor] for his office hours and I asked him if this was the right major for what I wanted to do because I wanted to study renewable energy. So, after having a conversation with him, he sent me an email link to the [scholarship program at the CC] website saying like, "This might be what you're interested in," he doesn't know for sure. So, after that I made an appointment with [a scholarship advisor] and spoke with him in further detail about the program and I thought it was a good pathway to take. [...] He gave me the options because they didn't accept electrical engineering. It was mechanical engineering, but [the CC] didn't have mechanical engineering and I was never a really a big chemistry person. So, I went with physics and then here I am.
>
> (F, Asian, not Hispanic or Latino; Physics major)

Lydia's experience with multiple advisors fully represented this finding. She was clear on her goal (a career in renewable energy) but uncertain on the path. Her navigational approach led to two community college faculty, a scholarship program, and ultimately transfer to a 4-year institution with a scholarship. In the process, she engaged another navigational capital skill by recognizing the value of expert guidance. Where participants faced institutional or academic challenges, they regularly and simultaneously engaged aspirational and navigational capitals. Across most demographic groups, external resources (including family, faculty, and staff) were sources of knowledge or structure that were supportive of participants' efforts.

## 5 | DISCUSSION

The present findings focus on MI STEM students who engage navigational and aspirational capital simultaneously. When both capitals are present, it is clear that students have "the ability to maintain hopes and dreams for the future, even in the face of real and perceived barriers" (Yosso, 2005, p. 77) and "the ability to maneuver through institutions not created with Communities of Color in mind" (Yosso, 2005, p. 80). This is the first attempt to study the intersection of these two components for STEM students. In the discussion that follows, we review connections between the findings, commonalities with extant literature, suggestions for future work, and implications for policy and praxis in higher education.

### 5.1 | Connections between findings

Collectively, the findings in this analysis indicate common facets of postsecondary experience for MI STEM students. We imagine the findings as layers of stories linked to mindsets and experiences that are also supported by external factors (people and social structures). The first layer of this experience is the American Dream. This concept suggests that in the United States any individual can make themselves a success, with elements of DIY (do-it-yourself), independence, and high expectations. This ethos is clearly reflected in the Individualization findings category, in which we see students being self-reliant and engaging priorities and milestones to reach their success independently.

The next layer of experience involves the perception of meritocracy, a system in which those who are most deserving win (without reference to systemic barriers to success). Meritocracy is necessary so that anyone can pull themselves up by their bootstraps (i.e., achieve the American Dream) by being the most deserving based on their efforts and attributes. This layer of experience is neatly portrayed in the Intrinsic Motivators category of findings. Within this category, hard work and success are in a direct relationship while participants feel obligated to take all opportunities for accessing success. Students take to heart the idea that working hard and taking every opportunity will help them to achieve their goals.

The external supports that keep the American Dream and meritocratic stories going are some of the External Factors that our participants look to as they navigate toward their goals. Before arriving to college, in some cases, the external identification of prestige encouraged students to enroll in the R1 university. Then, cultural directives and supports provided by family foster academic success and encourage students to prioritize that aspect of their lives. And, for some students, on-campus guidance from faculty members or groups helps in shaping their experiences. Thus, while the first layers of framing narratives proffer ideas of independence and individual agency, the final support for these university experiences comes from outside. It acknowledges, in alignment with the foundational principles of CCW,

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

that students are not alone on their pathways through college. Instead, their hopes are supported as they navigate through barriers by drawing on the expertise of others and their shared values.

## 5.2 | Commonalities with extant literature

Because this is the first study to consider specifically the intersection of two capitals, the findings of previous research often come either from aspirational or from navigational capital. However, one study of a Black male engineering student is a notable exception. The participant in Sellers and colleagues' work (2022) engages both capitals in multiple contexts: identifying and persisting in a relevant but difficult major, self-advocating for financial aid, and engaging multiple opportunities to meet his goals, throughout his educational journey (Sellers et al., 2022). These findings connect to each of the findings in this work, as engineering student engaged independently (Individualization), drew on a motivated mindset and focused on opportunities (Intrinsic Motivators), and built connections to others to support his efforts (External Factors). These neat overlaps between studies, as well as Sellers et al.'s (2022) consideration of all components of CCW, provide support for studying aspirational and navigational capital together and for the present findings.

Findings on aspirational capital in other works are also relevant to the present study's findings. A review of the STEM education literature links aspirational capital to motivations and persistence (Denton et al., 2020), and aligns to the second group of findings that highlight MI STEM students' Intrinsic Motivators. Additional close connections between the present findings, including where hard work is linked to success, provide evidence that engineering students view hard work in college as an investment in future success, and where aspirational capital is linked to their dispositions (Samuelson & Litzler, 2016), there are ties to the present Intrinsic Motivators findings. Aspirational capital is related to social networks in previous research (Pérez, 2014; Rincón & Rodriguez, 2020), as it is in the present research under the External Factors finding. Aspirational capital has not been studied on its own, outside analyses using the present dataset (see Sausner & Pitarresi, 2024); however, its co-occurrence with navigational capital in the this study supports previous identifications of this component elsewhere in studies of CCW.

Extant understandings of navigational capital are also mirrored in this study. Just as social relationships are part of CCW for MI students in postsecondary education (Holland, 2017; Liou et al., 2009; Pérez, 2014; Rincón & Rodriguez, 2020), social connections are salient in the final finding where participants seek external sources of support and information (i.e., via External Factors). Similar help-seeking is relevant for Latinx students transitioning from high school to college (Duncheon, 2018). Navigational capital is also linked to engineering competencies for students of color (Samuelson & Litzler, 2016) and to graduate school for Mexican-Americans, including through independent outreach to key stakeholders (Espino, 2014). Similar competencies and individual agency (e.g., through independent outreach) are navigational tactics highlighted in the present findings where students draw on their self-reliance, establish milestones and priorities, and seek external supports to guide them. This concurrence of navigational capital representations suggests that social connections and independent agency are important facets of this component of CCW, as they appear as navigational capital alone and in overlap with aspirational capital.

Engineering education researchers that engage the CCW framework look to understand most or all components of CCW for underrepresented minority or students of color and link the framework in that field to a specific outcome, such as persistence (Dika et al., 2018; Samuelson & Litzler, 2016). This study's findings suggest additional detail to bolster previous research that identifies aspirational capital as the "most important" for URM engineering "persisters" (Dika et al., 2018). Dika and colleagues' study (2018) links navigational and aspirational capital to engineering self-efficacy. In the present work, self-efficacy is suggested by students' extreme self-reliance and confidence in "hard work" as an approach to success, although further research using the specific self-efficacy construct would support this understanding. While this focus on URM students and engineering is crucial for the field, continued exploration in other areas of study will offer insights into disciplinary cultures and the work that MI students engage to navigate them.

In studies that specifically explored the experiences of Black male engineering students, familial capital overlapped with aspirational capital in the form of emotional support for this category (Tolbert Smith, 2022) and through parental encouragement throughout their education for graduate students (Burt & Johnson, 2018). Teachers were also supportive of Black male engineers' aspirations in STEM (Burt & Johnson, 2018). Although such encouragement would align with the External Factors finding, in the present work we did not find evidence of this within our data for Black male participants. This distinction suggests a need for renewed analysis of our dataset, identifying aspirational capital separately from navigational and considering the role of familial capital in the educational trajectories. Despite the

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

distinctions for Black male students, the present work expands beyond engineering and lends empirical support to this field.

Aside from the External Factors finding, works that investigated the CCW of Black, African American, or students of color in other STEM fields are also well connected to the present study. Much of the CCW-focused research designed to highlight the assets of Black, African American, and/or students of color identifies familial capital as an important facet of student experience. Examples of synergy include supportive emotional labor from the families of Black STEM majors (Ortiz et al., 2019) and for Black and Latinx STEM doctoral students (Pumaccahua & Rogers, 2022), and mothers activating aspirational capital around students of color's decision to attend college (Rincón et al., 2020, p. 13). In deciding to pursue STEM majors, external figures including parents and other siblings were likewise influential, which researchers link to the activation of navigational capital (Rincón et al., 2020, p. 13; Sellers et al., 2022). The "cultural notions of family" (Fernández et al., 2021, p. 153) extended to include student organizations, which further supported students of color in navigating college and STEM majors. Jaumot-Pascual et al. (2021) also included mentors, peers, and other school-based contacts as supportive of women of color's navigational capital in graduate school. Within Black male Greek letter organizations, familial and aspirational capital were identified as features of the organizations (Miller & Bryan, 2020). This collection of studies, featuring varied foci with a shared analysis of the experiences of students of color, highlights the functions of familial capital (including via family, fictive kin, and supportive institutional representatives) for the CCW and success of students in higher education. Likewise, the present study identifies family members and other supportive individuals at the intersection of aspirational and navigational capital in the External Factors finding.

Further extensions of familial capital for students of color also included an overlap with navigational capital. In the precollege pathway, for Black men who were engineering majors, navigational capital overlapped with familial capital through messaging and priorities that families set for their students. Such messaging, including "be selfish" and "be the best" (Tolbert Smith, 2022, p. 757), resonates with the Individualization (action-based) and Intrinsic Motivators (mindset-based) findings in the present study. Elsewhere, external sources such as knowledgeable faculty also supported Black STEM majors and they represented strategies, or navigational capital, that supported their learning (Ortiz et al., 2019). And, while Pumaccahua and Rogers (2022) studied both Latinx and Black students in STEM doctoral programs, their findings related to aspirational capital are similar to those in the present study. Among this group, "personal qualities/characteristics" were indicated as features of their aspirational and resistant capital, and as part of their navigational skills (Pumaccahua & Rogers, 2022, p. 11). The personal characteristics are not unlike the Individualization and Intrinsic Motivators findings of the present study. As this study features aspects of familial capital (as identified in previous research) at the intersection of aspirational and navigational capital, commonalities among students' experiences reflect points of multiple CCW components overlap and room for deep study or refinement of the framework components.

There are further common threads between studies of Latinx students' CCW and the present work. Latinx engineering transfer students create their own opportunities (Denton & Borrego, 2021), which aligns with the Intrinsic Motivators category finding in which students take advantage of every opportunity. Adjusting habits and seeking resources, another approach among Latinx engineering transfer students (Denton & Borrego, 2021), pairs with the present findings around Individualization in approaches. Finally, Latinx engineering transfer students connect with social agents as resources (Denton & Borrego, 2021), which echoes the External Factors category as participants engage university stakeholders and family as part of their college experience. The theme of family resources, seen here in examples of Hispanic or Latino students using values supported by family culture (i.e., External Factors), is also present where aspirational capital (among other components of CCW) is relevant for persistence leading to STEM opportunities for Latina/o students (Peralta et al., 2013). Finally, in studying Hispanic or Latino students' STEM identity development, themes overlapping with the present work include ties between aspirational capital and networks (i.e., External Forces) and students' independent development of navigational capital through online resources and other students, as in the Individualization (i.e., action-based) findings in this study.

Finally, while the present study includes Asian students in the analysis, other researchers exclude this group. Especially in STEM studies focused on higher education, Asian students' experiences are not studied with the CCW framework. This methodological choice aligns with the CRT roots of CCW and with the concept of underrepresented minoritized (URM) students, which does not include Asian students. The present findings (i.e., the overlap between the experiences of Asian students and other MI students) suggest the need for additional exploration, whether under the CCW framework or an alternative which is conceived in alignment with the "model minority" stereotype and its attendant damages.

21698030, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

### 5.3 | Suggestions for future work

Utilizing the CCW framework in STEM higher education extends the understanding about the limits that White supremacy imposes on all communities, including engineering. The framework's complexity, however, creates multiple facets that remain unexplored. Further work exploring specific components of the framework, the intersection of other relevant components (e.g., aspirational and familial capitals, social and navigational capitals), and the engagement of the framework (or components) in diverse contexts or by specific groups (e.g., transfer students) will deepen the understanding of student experience. Given the framework's foundation in CRT, exploring the experiences of Black or African American students is especially relevant and necessary. Such understanding can lead to change that breaks down the exclusionary realities in STEM and higher education.

Future analysis might also consider the layers of experience that these findings include, as indicated in this section. In particular, research around "grit," persistence, and the unequal expectations for MI students to display these traits in response to systemic oppression can be extended from other areas (see, e.g., Golden, 2017; Handsman, 2021) into STEM postsecondary education. This extension would look deeper into another narrative (i.e., grit), which may encourage MI students to employ emotional labor, through CCW, in pursuit of a STEM education. This angle is important to explore because it acknowledges students' strengths and questions the status quo of John Henryism, in which extreme effort is employed to cope with inequitable conditions (Lamb et al., 2021).

### 5.4 | Implications for policy and praxis

The asset-based CCW framework identifies the strengths of MI individuals and implies weaknesses of the systems around them. Among the weaknesses are universities that are designed to reproduce social structures benefiting upper class White men and disadvantaging those outside of this category. The Individualization finding category (related to student agency) and the Intrinsic Motivators finding category reflect the prevalence of meritocratic messaging throughout higher education. These connections should prompt thought about the aspects of curriculum and pedagogy that unnecessarily emphasize these narratives. Stakeholders can restructure their perspectives to build from students' CCW. Experiences that allow students to prioritize and identify milestones in collaborative learning may support their strengths. Similarly, supporting autonomy while offering guidance around the hidden curriculum will allow students to be self-reliant without putting them at risk because they are not experts in the process of college. Recognizing students' achievement and CCW-supported skills, perhaps through regular engagement with a knowledgeable stakeholder (e.g., advisor, faculty mentor, program lead), could build a feedback loop and support students. The feedback loop would indicate where MI students engage emotional and intellectual labor to move beyond unidentified barriers. This could be a starting point for institutions and/or units to reflect on their philosophy and messaging. On another level, individual educators and departments should recognize the cultural narratives, actors, and priorities that support their MI STEM students. Drawing on these narratives and student experience will build students' engagement and encourage inclusivity in future generations of STEM leaders. By intentionally adjusting messaging for students, stakeholders can interrupt narratives that isolate students and, instead, draw on students' intrinsic motivations.

Finally, just as MI students enter postsecondary education with assets, institutions have stakeholders who are among those assets. It is important to identify, recognize, and honor individuals who are important parts of students' networks. Building on their perspectives and expertise will expand their impact.

## 6 | CONCLUSION

The CCW framework reveals the roles of aspirational and navigational capitals for MI STEM students' college experiences. Participants in this study emphasize their responsibility and the accessibility of success. While the facets of their intrinsic motivation often align with majoritarian narratives, they pursue their goals individually with skills learned in community, seeking external guidance for additional support. These findings, including their overlaps and contrasts, highlight tactics and patterns at the intersection of aspirational and navigational capital. As an asset-based framework, CCW is useful for recognizing the ways in which students' goals (aspirational capital) and diverse approaches to meeting them (navigational capital) reflect meaningful labor within a complex hierarchical system. Stakeholders throughout postsecondary education and in diverse STEM contexts have the responsibility to recognize the ways in

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

which their structures and cultures require some students to exert additional effort and draw on unique resources to access what they need to learn.

## ACKNOWLEDGMENTS

The authors are grateful to Dr. Mozzie DosAlmas for their preliminary data collection that contributed to this work. They acknowledge with respect that this work was conducted at their university which rests on the occupied lands of the Onondaga Nation, firekeepers of the Haudenosaunee. This work was supported by the National Science Foundation through the S-STEM program (Award Number 79207).

## ORCID

*Erica B. Sausner* https://orcid.org/0000-0002-2222-4932
*Cassandra Wentzel* https://orcid.org/0009-0000-9135-1751
*James Pitarresi* https://orcid.org/0000-0002-6233-428X

## REFERENCES

Burt, B. A., & Johnson, J. T. (2018). Origins of early STEM interest for Black male graduate students in engineering: A community cultural wealth perspective. *School Science and Mathematics*, *118*(6), 257–270. https://doi.org/10.1111/ssm.12294

Campbell-Montalvo, R., Kersaint, G., Smith, C. A. S., Puccia, E., Skvoretz, J., Wao, H., Martin, J., MacDonald, G., & Lee, R. (2021). How stereotypes and relationships influence women and underrepresented minority students' fit in engineering. *Journal of Research in Science Teaching*, *59*(4), 656–692. https://doi.org/10.1002/tea.21740

Creswell, J. W. (2013). *Qualitative inquiry & research design* (3rd ed.). Sage Publications.

Denton, M., & Borrego, M. (2021). Navigational capital of Latinx engineering transfer students: A qualitative study. *Journal of Women and Minorities in Science and Engineering*, *27*(2), 61–86. https://doi.org/10.1615/JWomenMinorScienEng.2020035154

Denton, M., Borrego, M., & Boklage, A. (2020). Community cultural wealth in science, technology, engineering, and mathematics education: A systematic review. *Journal of Engineering Education*, *109*(3), 556–580. https://doi.org/10.1002/jee.20322

Dika, S. L., Pando, M. A., Tempest, B. Q., & Allen, M. E. (2018). Examining the cultural wealth of underrepresented minority engineering persisters. *Journal of Professional Issues in Engineering Education and Practice*, *144*(2), 1–9. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000358

Dika, S. L., Pando, M. A., Tempest, B. Q., Foxx, K. A., & Allen, M. E. (2015). *Engineering self-efficacy, interactions with faculty, and other forms of capital for underrepresented engineering students*. Paper presented at the 2015 IEEE Frontiers in Education (FIE) Conference. El Paso, TX. https://doi.org/10.1109/FIE.2015.7344119

Duncheon, J. C. (2018). "You have to be able to adjust your own self": Latinx students' transitions into college from a low-performing urban high school. *Journal of Latinos and Education*, *17*(4), 358–372. https://doi.org/10.1080/15348431.2017.1355248

Espino, M. M. (2014). Exploring the role of community cultural wealth in graduate school access and persistence for Mexican American PhDs. *American Journal of Education*, *120*(4), 545–574. https://doi.org/10.1086/676911

Fernández, É., Rincón, B. E., & Hinojosa, J. K. (2021). (Re)creating family and reinforcing pedagogies of the home: How familial capital manifests for students of color pursuing STEM majors. *Race Ethnicity and Education*, *26*(2), 147–163. https://doi.org/10.1080/13613324.2021.1997971

Golden, N. A. (2017). "There's still that window that's open": The problem with "grit". *Urban Education*, *52*(3), 343–369. https://doi.org/10.1177/0042085915613557

Handsman, E. (2021). From virtue to grit: Changes in character education narratives in the U.S. from 1985 to 2016. *Qualitative Sociology*, *44*, 271–291. https://doi.org/10.1007/s11133-021-09475-2

Holland, N. E. (2017). Beyond conventional wisdom: Community cultural wealth and the college knowledge of African American youth in the United States. *Race Ethnicity and Education*, *20*(6), 796–810. https://doi.org/10.1080/13613324.2016.1150823

Inclusive Language Guidelines. (2021). Retrieved from. https://www.apa.org/about/apa/equity-diversity-inclusion/language-guidelines.pdf

Jaumot-Pascual, N., Ong, M., Silva, C., & Martínez-Gudapakkam, A. (2021). Women of color leveraging community cultural wealth to persist in computing and tech graduate education: A qualitative meta-synthesis. *Education Sciences*, *11*(12), 797. https://doi.org/10.3390/educsci11120797

Krathwohl, D. (2009). *Methods of educational and social science research: The logic of methods* (3rd ed.). Waveland Press.

Lamb, R., Hoston, D., Lin (林静), J., & Firestone, J. (2021). Psychological allostatic load: The cost of persistence in STEM disciplines. *Research in Science Education*, *52*, 1187–1206. https://doi.org/10.1007/s11165-021-10000-2

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park.

Liou, D. D., Antrop-González, R., & Cooper, R. (2009). Unveiling the promise of community cultural wealth to sustaining Latina/o students' college-going information networks. *Educational Studies*, *45*(6), 534–555. https://doi.org/10.1080/00131940903311347

Listman, J. D., & Dingus-Eason, J. (2018). How to be a deaf scientist: Building navigational capital. *Journal of Diversity in Higher Education*, *11*(3), 279–294. https://doi.org/10.1037/dhe0000049

MaxQDA Analytics Pro. (2018). *MaxQDA*. VERBI.

McGee, E. O. (2018). "Black genius, Asian fail": The detriment of stereotype lift and stereotype threat in high-achieving Asian and black STEM students. *AERA Open*, *4*(4), 1–16. https://doi.org/10.1177/2332858418816658

Miller, J., & Bryan, N. (2020). This is how we do it: Toward the notion of otherbrothering in the research on black male collegians and black male Greek-lettered organizations. *The Journal of Negro Education*, *89*(3), 203–214.

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Monarrez, A., Wagler, A., & Wagler, R. (2019). Latinx STEM teacher formation through a cultural wealth lens. *Journal of Hispanic Higher Education*, *20*(2), 164–178. https://doi.org/10.1177/1538192719835685

Morales-Chicas, J., Gomez, M., Gussman, M., & Kouyoumdjian, C. (2022). A cultural wealth approach to understanding Latin@s' STEM mentee and mentor experiences. *Equity and Excellence in Education*, *55*(4), 371–385. https://doi.org/10.1080/10665684.2022.2047411

National Center for Science and Engineering Statistics. (2021). *Women, minorities, and persons with disabilities in science and engineering: 2021*. Special Report NSF 21-321. Alexandria, VA: National Science Foundation. https://nces.nsf.gov/wmpd.

Ong, M., Smith, J. M., & Ko, L. T. (2018). Counterspaces for women of color in STEM higher education: Marginal and central spaces for persistence and success. *Journal of Research in Science Teaching*, *55*(2), 206–245. https://doi.org/10.1002/tea.21417

Ortiz, N. A., Morton, T. R., Miles, M. L., & Roby, R. S. (2019). What about us? Exploring the challenges and sources of support influencing black students' STEM identity development in postsecondary education. *The Journal of Negro Education*, *88*(3), 311–326. https://doi.org/10.7709/jnegroeducation.88.3.0311

O'Shea, S. (2016). Avoiding the manufacture of 'sameness': First-in-family students, cultural capital and the higher education environment. *Higher Education*, *72*(1), 59–78. https://doi.org/10.1007/s10734-015-9938-y

Peralta, C., Caspary, M., & Boothe, D. (2013). Success factors impacting Latina/o persistence in higher education leading to STEM opportunities. *Cultural Studies of Science Education*, *8*(4), 905–918. https://doi.org/10.1007/s11422-013-9520-9

Pérez, D. I. (2014). Exploring the nexus between community cultural wealth and the academic and social experiences of Latino male achievers at two predominantly white research universities. *International Journal of Qualitative Studies in Education*, *27*(6), 747–767. https://doi.org/10.1080/09518398.2014.901573

Pérez, D. I., & Taylor, K. B. (2016). Cultivando logradores: Nurturing and sustaining Latino male success in higher education. *Journal of Diversity in Higher Education*, *9*(1), 1–19. https://doi.org/10.1037/a0039145

Pumaccahua, T., & Rogers, M. R. (2022). Academic warriors: Community cultural wealth among Latinx and black STEM doctoral students at predominately white institutions. *Journal of Latinos and Education*, *22*(5), 1870–1884. https://doi.org/10.1080/15348431.2022.2057988

Revelo, R. A., & Baber, L. D. (2018). Engineering resistors: Engineering Latina/o students and emerging resistant capital. *Journal of Hispanic Higher Education*, *17*(3), 249–269. https://doi.org/10.1177/1538192717719132

Riegle-Crumb, C., King, B., & Irizarry, Y. (2019). Does STEM stand out? Examining racial/ethnic gaps in persistence across postsecondary fields. *Educational Researcher*, *48*(3), 133–144. https://doi.org/10.3102/0013189X19831006

Rincón, B. E., Fernández, É., & Hinojosa, J. (2020). "I wanted to follow in her footsteps": Activating, nurturing, and extending community cultural wealth for students of color entering STEM pathways. *Teachers College Record*, *122*(9), 1–36. https://doi.org/10.1177/016146812012200903

Rincón, B. E., & Rodriguez, S. (2020). Latinx students charting their own STEM pathways: How community cultural wealth informs their STEM identities. *Journal of Hispanic Higher Education*, *20*(2), 149–163. https://doi.org/10.1177/1538192720968276

Rodriguez, S. L., Ramirez, D., Lehman, K. J., & Sax, L. J. (2023). Utilizing community cultural wealth to explore the experiences of Latina undergraduate students in computing. *Journal of Women and Minorities in Science and Engineering*, *29*(3), 1–24. https://doi.org/10.1615/JWomenMinorScienEng.2022039365

Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Sage Publications.

Samuelson, C. C., & Litzler, E. (2016). Community cultural wealth: An assets-based approach to persistence of engineering students of color. *Journal of Engineering Education*, *105*(1), 93–117. https://doi.org/10.1002/jee.20110

Sausner, E. B., & Pitarresi, J. M. (2024). Motives and tactics: Representations of aspirational capital among marginalized-identity STEM students. *Journal of Women and Minorities in Science and Engineering*. (In press).

Sellers, V. B., Martin, J. P., & Seraphin, M. (2022). A narrative inquiry approach to community cultural wealth of Black men in engineering. *Journal of Women and Minorities in Science and Engineering*, *28*(4), 69–95. https://doi.org/10.1615/JWomenMinorScienEng.2021038012

Taylor, E. (2016). The foundations of critical race theory in education: An introduction. In E. Taylor, D. Gillborn, & G. Ladson-Billings (Eds.), *The foundations of critical race theory in education* (pp. 1–11). Routledge.

Tolbert Smith, D. L. (2022). "They are here to support me": Community cultural wealth assets and precollege experiences of undergraduate black men in engineering. *Journal of Engineering Education*, *111*(4), 750–769. https://doi.org/10.1002/jee.20480

Vespa, J., Medina, L., & Armstrong, D. (2020). "Demographic turning points for the United States: Population projections for 2020 to 2060." *Current Population Reports*. 25–1144. U.S. Census Bureau, Wasgington, DC. https://www.census.gov/content/dam/Census/library/publications/2020/demo/p25-1144.pdf

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge University Press.

Yosso, T. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education*, *8*(1), 69–91. https://doi.org/10.1080/1361332052000341006

## AUTHOR BIOGRAPHIES

**Erica B. Sausner** is the Recruitment and Development Coordinator for STEP and CSTEP at Binghamton University, SUNY. 4400 Vestal Pkwy E., Binghamton, NY 13902, USA; esausner@binghamton.edu

**Cassandra Wentzel** is a Counselor for EOP at Binghamton University, SUNY. 4400 Vestal Pkwy E., Binghamton, NY 13902, USA; cwentzel@binghamton.edu

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

**James M. Pitarresi** is Vice Provost for Online and Innovative Education, Distinguished Teaching Professor, and Executive Director of the Center for Learning and Teaching at Binghamton University, SUNY. SUNY. 4400 Vestal Pkwy E., Binghamton, NY 13902, USA; jmp@binghamton.edu

**How to cite this article:** Sausner, E. B., Wentzel, C., & Pitarresi, J. (2024). "I know what I need to learn": The intersection of aspirational and navigational capitals for marginalized-identity STEM students. *Journal of Engineering Education*, *113*(2), 488–508. https://doi.org/10.1002/jee.20595

## APPENDIX A

### INTERVIEW PROTOCOL SAMPLE QUESTIONS

**Interview protocol**: Transfer support experience: Exploring the theory of action.

Before you arrived at [R1], what did you expect studying science at [R1] would be like? (For students not yet at [R1]: What do you expect studying science at [R1] to be like?) In what ways has your actual experience been similar or different from this expectation?

**Interview protocol**: Reflecting on progress and practice.

Describe a time period or an instance of academic challenge.

Who do you reach out to when you have an academic challenge? When you have an academic experience you want to celebrate?

**Interview protocol**: Experience a STEM student and the scholarship theme.

Please describe what your life is like at [R1].

In your major?

As a student?

As a [program participant]?

**Interview protocol**: Defining the field.

What are the connections between your field and [ME, PHYS, CHEM]? How do you know?

What other disciplines/fields of study are relevant to your major?

What fields of study are interesting but not relevant to your major?

**Interview protocol**: Communities, belonging, identities, and practice.

What are some things you are proud of about this past school year?

What communities do you belong to? What communities are you near, but not quite "in"?

## APPENDIX B

### CODEBOOK

| Theoretical and methodological identifier | Codes and sub-codes |
|---|---|
| CoP | Institutional/externally determined attempt at reification |
| | Institutional/externally determined "practice" expectation |
| | Institutional/externally determined "community" |
| | Identity |
| | Negotiating repertoire |
| | Via accountability to "x" enterprise |
| | Via mutuality of engagement (recognition) |
| | Boundary object |
| | Brokering between groups |

(Continues)

21698030, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

| Theoretical and methodological identifier | Codes and sub-codes | | |
|---|---|---|---|
| | Reification | | |
| | Physical artifact | | |
| | Adapting a known meaning/concept | | |
| | Adopting meaning made by "old hands" | | |
| | Meaning making via communication | | |
| | Patterns | | |
| | Shared practice | | |
| | Via shared repertoire (evidence of shared reification) | | |
| | Via mutual engagement | | |
| | Via joint enterprise | | |
| CCW | Resistant capital | | |
| | Familial capital | | |
| | Linguistic capital | | |
| | Navigational | | |
| | Aspirational capital | | |
| CCW + Social capital | Social capital | | |
| Social capital | Success | | |
| | Participation | | |
| | Access | | |
| Student experience | Student experience | | |
| | Reputation[a] | | Link to broad/global goals |
| | Academic curiosity[a] | | Interdisciplinary (experience) |
| | Approaches to academic challenges[a] | | Academic and cultural values linked |
| | Career readiness[a] | | Research process inculturation |
| | Background/upbringing[a] | | Scientific values |
| | Geography[a] | | Scientific identity |
| | Finding their way/testing the waters[a] | | Student services engagement |
| | Previous academic experience[a] | | Feedback |
| | Absence of social capital/social ties[a] | | Perceived academic fit |
| | Out-of-class engagement[a] | | Classroom engagement |
| | High goals/expectations/motivation[a] | | Cls engag-prof |
| | Student engagement in other areas (e.g., clubs)[a] | | Cls engag-peers |
| | Only/logical option[a] | | Social activities |
| | Foregone conclusion[a] | | Friendship |
| | Academic challenges | | Psychosocial support |
| | Wage-earning work | | Cohort presence |
| | Safe space | | Living/learning community |
| | Active learning | | Peer support network |
| | Transfer student capital | | Teamwork |
| | Advising | | Cognitive equity |
| | Coaching | | Data-based practice change |
| | Transfer student programming | | Goal-based motivation constructs |
| | Transfer preparedness | | |
| | Persistence[a] | | |
| | Expectations[a] | | |
| | Programming note[a] | | |

[a] Indicates inductive code.

21698830, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jee.20595 by Suny Binghamton, Wiley Online Library on [27/09/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License