Motives and Tactics: Representations of Aspirational Capital Among Marginalized-Identity STEM Students

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Abstract

While engaging supports offered through a scholarship program, marginalized-identity STEM students draw on community cultural wealth to persist in an environment that is not designed for their success. This analysis focuses on the presence of aspirational capital: hope and goals that prevail despite systemic barriers for marginalized-identity individuals and communities. Semi-structured interview data from 31 students, through the engagement of basic qualitative methodology, reveal students' ongoing search and adaptation for institutional opportunities, engagement of individualistic tactics including keen self-awareness and narratives of "hard work" to meet established goals, relationships to trusted guides, and community-serving orientations as representations of their aspirational capital.

Keywords: community cultural wealth; aspirational capital; STEM; higher education; marginalized students

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The engagement of Yosso's (2005) community cultural wealth (CCW) framework in science, technology, engineering and mathematics (STEM) higher education has expanded to the point that researchers have begun systematically reviewing this literature (Denton et al., 2020). Through this review, and the studies it analyzes, there is a clear frame for understanding the experience for marginalized, non-dominant identity students—something beyond the traditional "cultural capital" understandings that take a deficit-based perspective. In most studies, however, the authors identify the presence of all forms of CCW, sometimes narrowing their focus by contexts (e.g., engineering undergraduate) or demographics (i.e., Black students). These studies review the broad strokes of multiple components of CCW. Although aspirational capital, "the ability to maintain hopes and dreams for the future, even in the face of real and perceived barriers," (Yosso, 2005, p. 77), is very frequently identified as a component of CCW, STEM education researchers and practitioners are missing a detailed account of it. This limits the understanding of resources that marginalized-identity students use to overcome oppressive structures in STEM. In response, the present study provides analysis of aspirational capital's presence in the experiences of marginalized-identity STEM college students. It identifies both the reasons behind aspirational capital's use (motives) and the ways in which it is engaged (tactics). This deeper look is a starting point for understanding the importance of aspirational capital in the postsecondary experiences of many STEM students.

From this foundation we pose a single research question: In what ways does aspirational capital (Yosso, 2005) manifest for STEM students from marginalized communities?

Background Literature

Community Cultural Wealth: An Alternative to Cultural Capital

The CCW framework (Yosso, 2005) was elaborated in response to cultural capital that is favored and reproduced in systems of education, to the detriment of communities of color and other oppressed groups. Cultural capital, as traditionally conceived by Bourdieu (1986), highlights the primacy of White, middle to upper class values and status markers. This system rewards cultural and social capitals that reflect middle class or elite markers and prestigious social networks (Bourdieu, 1973, 1986), which are marginalizing by definition. Bourdieu's cultural capital situates individuals and groups who are outside of the dominant norm as deficient.

In contrast, CCW looks to the assets developed by oppressed communities that function within the structures of White supremacy. The CCW framework (Yosso, 2005) recognizes students' backgrounds as assets and rejects deficit perspectives. Yosso (2005) builds on Critical Race Theory (CRT) and proffers CCW as a collection of alternative capitals created in communities that have survived disenfranchisement and exclusion. The "cultural wealth" that these groups build includes social capital (networks of people and resources), familial capital (cultural knowledges), navigational capital (skills to maneuver through complex, exclusionary systems), resistant capital (knowledges and skills built in opposition to oppressive forces), linguistic capital (developed through multiple language/style communication) and aspirational capital—hope in the face of systemic and other barriers (Yosso, 2005). The asset-based perspective of CCW maintains that alternative capitals are not less valuable than traditional social and cultural capitals. This inclusive system offers a multifaceted lens for analyzing student experience. The current literature base, however, offers limited research into the specifics of each

form of capital. Thus, the present study seeks to fill this gap through an in-depth analysis of aspirational capital.

The CCW framework is well suited to analyzing the experiences of marginalized-identity STEM students. To outline the analytical value to date, as well as gaps in understanding, Denton et al. (2020) completed a systematic literature review of STEM education research that applied the framework. That their initial search strategy yielded nearly 600 studies, including more than 100 results in STEM, indicates the prevalence of the framework. The smaller, final group of studies analyzed (n=33) suggests that the framework is applicable to STEM, yet empirical work that includes a focus on STEM education with CCW as an outcome is limited. In the review that follows, we highlight some key themes of the empirical studies that engage CCW in the study of STEM education.

Empirical Work with the CCW Framework in STEM Education

Despite the growing prevalence of CCW in STEM education research, there is a limited understanding of each component that Yosso (2005) identified. Instead, research is narrowed by demographic group or academic field. Frequently, the literature highlights the value of CCW for Latinx students across contexts and majors (Denton & Borrego, 2021; Mein et al., 2022; Monarrez, et al., 2019; Morales-Chicas et al., 2022; Peralta et al., 2013; Rincón et al., 2020; Rincón & Rodriguez, 2020). In other cases, demographics are more broad, including "underrepresented minorities" (URMs) or students of color (Dika et al., 2015; Samuelson & Litzler, 2016). Finally, there are studies that look at the intersection of a particular student identity and another theoretical component such as academic and social experiences (Pérez, 2014), STEM identity (Ortiz et al., 2019; Rincón & Rodriguez, 2020), persistence in STEM education (Dika et al., 2015; Peralta et al., 2013; Samuelson & Litzler, 2016), and engineering

(Mein et al., 2022; Samuelson & Litzler, 2016; Sellers et al., 2022). Studies that narrow their focus by discipline, demographics, or by another construct (e.g., STEM identity), often fail to investigate the depth of individual components of CCW resulting in a broad but shallow understanding of the framework's relevance for STEM students.

The broad applicability of the CCW framework suggests the utility of its' components for understanding student experience. Developing more thorough studies of each component offers the opportunity for better understanding and translation to policy and praxis that serve marginalized-identity STEM students. This deeper engagement of single components has begun with inquiries into navigational capital (Denton & Borrego, 2021; Listman & Dingus-Eason, 2018), resistance capital (Revelo & Baber, 2018), and familial capital (Fernández et al., 2021). While focused analysis of CCW has expanded, STEM discipline-based education research (DBER) has yet to dig deeply into aspirational capital and its' representations for marginalized-identity STEM students. There are indications of aspirational capital, however, throughout extant studies, as reviewed in the section that follows.

Understanding Aspirational Capital

Throughout the STEM education literature that engages the CCW framework, aspirational capital is highlighted as a foundational feature of student experience. Denton et al. (2020), identified 28 (out of 33) studies that include aspirational capital among their findings. Among this collection, 13 of the 33 studies focused on STEM broadly (rather than a specific field, such as engineering), as does the present analysis. Most of the STEM studies (12 out of 13) included aspirational capital in their findings. This component of CCW was linked to motivation, persistence, the presence of key stakeholders or guides, and was often co-represented with navigational and familial capital (Denton et al., 2020). The presence of aspirational capital in

diverse contexts, its link to factors known to support student success, and its ties to other CCW components highlights the relevance of aspirational capital as part of student experience and merits deeper investigation.

Although empirical work identifies aspirational capital in many contexts, researchers provide nuance about the presence of this component by their choice of verbs. As a result, the language around aspirational capital for marginalized-identity STEM students is varied. Much of the literature refers to aspirational capital in terms of its appearance for example by "emerging" (Dika et al., 2018; Morales-Chicas et al., 2022), "activating," (Fernández et al., 2021) or as something "expressed" in narratives (Mobley and Brawner, 2018 as cited in Denton, et al 2020). This component is also identified through actions including degree attainment (McPherson, 2012 as cited in Denton et al., 2020) and in relationship to obstacles (Chavez, 2018 as cited in Denton et al, 2020; Morales-Chicas et al., 2022). Rincón and Rodriguez (2020) also discuss aspirational capital in relation to its sources, including peers or home communities. It is also identified as a disposition or attitude (Samuelson and Litzler, 2016). Overall, this component is tightly linked with the concept of "hope" (see, for example, Rincón and Rodriguez, 2020), a feeling, and with goals. Goals were identified tied to familial capital (Morales-Chicas et al., 2022) and also inferred, more generally (Denton & Borrego, 2021; Denton et al., 2020). In the present findings aspirational capital is indicated by actions that students take and the motivations that drive them. The actions align to studies that indicate the presence of aspirational capital as a representation of agency (e.g., through emergence or attaining an objective). Further, we identify aspirational capital in the motivations that are linked to those tactics among participants. In these motivations we see the hopes that push students to success, which ties to other studies that have identified

dispositions (Samuelson & Litzler, 2016) or goals (Denton & Borrego, 2021; Denton et al., 2020) as relevant to this component of Yosso's (2005) framework.

Although the engagement of CCW in STEM DBER is broad, the literature that relates specifically to this study is relatively thin. Empirical work focused on STEM students and CCW is limited to Latinx students. While other studies include aspirational capital in their findings, they narrow the analysis by major, an analytical choice that does not apply to the present study. Thus, in the section that follows we discuss aspirational capital for Latinx students in STEM, choosing to accept the narrower scope of participants in favor of including a broader range of academic areas (i.e., STEM rather than engineering).

Aspirational Capital for Latinx STEM students

Aspirational capital was important to Latinx STEM students on an individual level. For future educators, it was an internal or foundational component of their teaching persona (Monarrez et al., 2019) and was supportive of STEM (teacher) identities (Monarrez et al., 2019; Rincón & Rodriguez, 2020), student mentor motivation (Morales-Chicas et al., 2022), and college persistence in pursuit of STEM opportunities (Peralta et al., 2013). These features of the postsecondary experience (i.e., identity, motivation, and persistence) are relevant for other identity groups beyond the Latinx students in STEM. Knowing more about aspirational capital in other groups throughout STEM will reveal additional details about its role for non-dominant students.

Aspirational capital also connected to Latinx STEM students' family and extended kin networks. It was identified in Latinx STEM teachers' passions for content, students, and community (Monarrez et al., 2019). Among Latinx STEM students who served as mentors for younger students, it linked to their families' expectations; they furthered this capital by serving

as role models and motivation for their mentees (Morales-Chicas et al., 2022). Finally, in support of Latinx students' persistence, aspirational capital was tied to their parents' challenging experiences and transmitted through encouraging family narratives (Peralta et al., 2013). These family and extended kinship relationships to aspirational capital highlight its importance for individuals (e.g., in persistence) as well as for communities of students (e.g., through mentor relationships) and underscores individual agency alongside the influences of broader networks (e.g., through motivating family narratives).

Beyond family, aspirational capital among Latinx students was also tied to the concept of community either in forming a sense of *comunidad* at college (Rincón et al., 2020) or deriving aspirational capital from peers and communities to support STEM identity formation (Rincón & Rodriguez, 2020). It was also identified in Latinx STEM teachers' passions for content, students, and community (Monarrez et al., 2019). These priorities link to the CCW framework's development in community and emphasize this important motivator even when students leave their "home" communities.

Despite aspirational capital's ties to multiple areas of students' experiences, it has yet to be examined through an analysis which is dedicated to this component of CCW and its nuanced representation. The present study both expands the demographics of students and their disciplinary engagement, while crafting a narrower focus on the specifics of aspirational capital. As suggested by previous literature that exposes its presence, a deep understanding of this component can further support postsecondary STEM students' success.

Data and Methods

Context of the Study

This study was supported by funding from the National Science Foundation (Award No. 1742056). The goal of this program was to support the graduation of low-income students in STEM fields. Within this award, students were recruited from chemistry, physics, or mechanical engineering majors under a broad thematic umbrella "Smart Energy." Student participants were recruited from a research-intensive (R1) university in the Northeast and from two community colleges—one rural and one urban—with a transfer pathway and funding post-transfer. The programmatic emphasis was on "high potential" students with a 3.0 or higher GPA; however, this was not a firm cut-off, and students with lower GPAs were also enrolled in the program. Ongoing recruitment led to scholarship recipients with varied lengths of engagement. Some students participated just for their final year of college while others were engaged from their enrollment at a community college through graduation from the four-year institution. A further outcome of ongoing recruitment and graduation cycles was the varied enrollment, ranging from 10 participants to more than 40 per academic year, across the participating institutions.

Participants in the program received a financial scholarship and access to ongoing supports including mentoring, on-campus study space, and a weekly seminar with presentations centered on community development, academic research, and professional development. Students at the community college were encouraged to attend the seminar via Zoom (during the COVID-19 pandemic, all seminar content was presented via Zoom).

Data Set

Included in the data set for these findings are 54 thematic, semi-structured interviews, fieldnotes (n=11), and student reflections (n=7). The fieldnotes featured researcher observations about student interactions with one another including the topics and patterns of engagement. These notes were taken at ad hoc gatherings of students, including meet-and-greet lunches

(brownbag events and community meals sponsored by the first author). Several students submitted written responses to a common prompt on metacognition. This corpus of data allowed for a deep analysis of student experience (in formal and informal settings) and of personal reflections.

The thematic, semi-structured interviews followed theoretical priorities related to communities of practice (Wenger, 1998) (i.e., they asked questions related to key components of communities of practice) and student experience; there were five interview themes, in total. A total of 31 students participated, with some participants engaging in multiple interviews. They were conducted in a one-on-one setting (in person or online), transcribed verbatim, and analyzed in MaxQDA (*MaxQDA Analytics Pro*, 2018). Each interview lasted between 20 minutes and 75 minutes, with the longer interview sessions including two interview protocols. Protocol themes included communities and belonging, the transfer student experience, understanding the field of study (smart energy), reflection on progress and practice in academic realms, and experience as a STEM student and scholarship recipient. Most interviews were conducted by the first author. Some participants' interviews pre-dated the first author's participation in the research and, thus, were conducted by another researcher, following protocols with slightly different foci and structure. These interview protocols were designed as the program was launched and their prompts were later folded into the thematic interviews. An overview of protocol foci can be found in Table 1.

[INSERT TABLE 1 HERE]

Participants from two transfer institutions and a predominantly White (PWI), research intensive university consented to participate in this research in accordance with Institutional Review Board (IRB) human subject protocol. They embodied a multitude of identities that are

marginalized in their majors of study (physics, mechanical engineering, and chemistry). All students were low-income, US citizens or permanent residents, and enrolled full-time at the time of scholarship disbursement, although students occasionally reduced their enrollment status throughout the semester. While program participation was broad, for the purpose of this study, White, male participants were excluded from data analysis. This choice aligned to the CRT foundations of the CCW (Yosso, 2005) framework. Women who self-identified as White were not excluded because their identification as women represents a marginalized identity in STEM. The inclusion of White women, and to some degree Asian students, reflects an effort to understand the broader context of STEM for non-dominant individuals and is not unique in the literature (see Listman & Dingus-Eason, 2018). However, it is not perfectly aligned to the CRT roots of the CCW framework, which is a limitation of the present study.

The demographics of student participants are presented in Table 2. Males, as is common STEM, are slightly over-represented (n=17) compared to female participants (n=14). Students identified with varying racial and ethnic identity groups, including some who chose not to identify their race.

[INSERT TABLE 2 HERE]

Protection of Vulnerable Populations

The human subjects consent process, governed by the IRB, was the foundation of participant protection for this work. The participants were supported through rapport-and trust-building throughout their participation in the scholarship program and the research. As part of the programming and research, participants were invited to choose their own pseudonyms and to provide specifics on their gender identities; where relevant, these pieces of information are included in the findings (F: female, M: male; no students identified themselves outside of this

binary). The pseudonym choice was offered to allow participants to feel represented in the work, as they were guided to consider culturally aligned pseudonyms that protected their identity. For each interview session participants were reminded of their option to skip uncomfortable questions, should they arise. In addition to person-to-person efforts, the IRB process includes data storage protections that help maintain the confidentiality of students' participation.

Methodological perspective

This study was drawn from a larger dataset that sought an understanding of the student experience. This goal led to a "research [question] that [did] not fit neatly within the confines of a single established methodology" (Kahlke, 2014, p. 38) and thus the research design featured a generic qualitative approach. Also termed "basic interpretive qualitative study," this is appropriate to "discover and understand a phenomenon, a process, the perspectives and worldviews of the people involved, or a combination of these." (Merriam, 2002, p. 6). This methodology allows for flexibility to include aspects of multiple methodologies (Kahlke, 2014). Narrative inquiry, for example, influenced the interview protocols that centered on student experiences; and ethnography was applicable as students can be considered member of a culture-sharing group with patterns across their experiences (Creswell, 2013). Moreover, by identifying CCW as an alternative to the extant power structure, aspects of critical ethnography are also present (Creswell, 2013, p. 93). The thematic nature of the present findings is especially reflective of the generic qualitative approach and ethnography. Since the distinction among the applicable methodologies was not retained in this study, however, generic qualitative (or basic qualitative) approach was applied (Kahlke, 2014).

The theoretical foundations of data collection (communities of practice and student experience) differed from the analytical framework (CCW) we engaged for this study. They are

unified, however, by sampling for the present analysis. The study participants are members of communities that are systemically disenfranchised. In higher education, they bring the whole of themselves: their identities cannot be separated from how they experience college. Although the lived experiences of marginalized-identity participants were not explored with specific orientation towards their marginalization, those realities are ever present and crucial to their perspectives. Moreover, experiences of the universities cannot be separated from Whiteness. Put succinctly in an introduction to CRT in education, Taylor (2016) explains:

> Racial inequality and discrimination in matters such as hiring, housing, criminal sentencing, education, and lending are so widespread as to be uninteresting and unconcerning to most Whites.....In stark contrast, non-Whites have a startlingly clear view of the coercion that White supremacy has constructed. From birth, they generally have first-hand knowledge, as well as multigenerational experience of the political, social, historic, and persistent disadvantages of not being White. (p. 4)

With this knowledge and experience, the participants generously shared about their college experience and the analytical work of the present study was to identify the assets of aspirational capital that are represented within that experience.

Analytical methods

The present analysis relies on multiple rounds of coding by a single researcher (the first author). The start list, or preliminary inductive codes (Creswell, 2013), was drawn from literature on student experience (Miles & Huberman, 1994 as cited in Saldaña, 2013, p. 144). This list included sub-codes that related to extant models (Saldaña, 2013, p. 77) including communities of practice (Wenger, 1998) and social capital (supported by Gidley et al., 2010). In addition,

analytical "elaborative coding," supported the goal of this work: confirming the extant literature and expanding it with further detail and breadth (Saldaña, 2013, p. 229).

To efficiently winnow the data, analysis before the second round of coding was limited to first-round codes with theoretical and conceptual links to the CCW analytical framework, representing a data analysis spiral (Creswell, 2013). The second round used inductive, theory-based coding to highlight students' experiences with components of CCW. Finally, synthesizing the present findings required a focus on "aspirational capital," excerpts from the data. Although this code often overlapped with other components of CCW, the present analysis centers on aspirational capital in all instances—whether it appeared independently or with other components of CCW.

A final round of analysis disaggregated student participants by identity categories including sex, race, and ethnicity. This analysis, completed after the findings were developed, highlighted similarities and differences among marginalized-identity groups in STEM. In this stage, after separating excerpts coded as "aspirational capital," the first author used the paraphrase function in MaxQDA (*MaxQDA Analytics Pro*, 2018) to create one-sentence summaries. Then, reviewing those summaries for ideas shared among participants within a marginalized-identity group, she created short memos of key ideas. Finally, the first author grouped key ideas from the memos of each identity grouping. This resulted in some additional facets of each finding theme. Because participant representation in each racial and ethnic identity grouping, including separated by sex, is uneven, these findings are included as additional support for the larger findings, rather than deep investigations into any identity groups' experience.

Researcher identity

As a White, heterosexual, cis-gendered female researcher with a PhD, the first author's positionality contrasts that of the participants. Moreover, joining the research team after another postdoctoral scholar began the program and research meant that she met the participants as the second person to fill a largely undefined role ("Post-Doc"). Data collection, however, began to represent a reciprocal process. The first author worked to build rapport with students, drawing on potential shared experiences such as first-generation college student status, having experienced financial uncertainty and self-support expectations in college, and familiarity with some Latinx cultures through lived experiences in two Central American nations. Her academic studies and understanding of the literature related to inequitable education supported her rapport-building, as well. Most importantly, however, she centered students by getting to know them individually and understood the researcher and post-doc role as one that serves student needs. These approaches were built on an asset-based perspective that acknowledged the realities of inequity in STEM education, as well as researcher positionality.

The second author is a cis-gendered male, white administrator with a PhD. His role in the preparation of this study included reviewing drafts and sharing sensemaking about the findings. In this, he supported contributions to the discussion and conclusion. His positionality was not relevant for data collection but was important to consider for potential policy and praxis changes based on the findings of this research. The second author engaged his experience and position to understand the implications of the findings in STEM contexts and the university more broadly.

Limitations

Race, education level, sexual orientation, and age were stark chasms between some of the participants and the first author. Attempts to learn from non-dominant identity groups and bracket individual experience are imperfect processes that she, nonetheless, engaged throughout

this study. Asking individuals to describe experiences of vulnerability requires trust, and we cannot be certain of the levels of trust gained with each participant. This limits the data presented here and is a place for researchers of differing lived experiences to continue this work.

Despite the inclusion of two community colleges (which generally have better representation of marginalized-identity students) and multiple majors in this work, participant demographics in this study are not representative of the student populations at these institutions. To understand the experiences of students in this program and study, early analysis and key findings of this study collapsed gender, race, and ethnic identities of students. This limitation threatened to ignore nuance and depth available within single identity components. Current scholarship warns against this, cautioning about the invisbilization of Black students in particular, by artificially identifying and reifying "BIPOC" as a community type or label (Kirkland, 2021). The final round of analysis attempted to better serve students with diverse identities, in response to this. This was designed to balance the homogenization under the term "BIPOC," with the need to represent participants who consented to this study and whose voices deserve to be heard. Thus, by collapsing identity groups and analyzing them separately, the present study avoided setting up small numbers of individuals as the spokespeople for their racial or ethnic group. However, beyond the scope of this study there remains much work to be done in building better understandings of all marginalized-identity groups' experiences in STEM.

Results

Studying the aspirational capital of marginalized-identity STEM students revealed four important themes. Each theme suggests a motivation for students, while two themes feature the additional nuance of tactics for acting on that motivation. Motivations include hopes and goals that students pursued. Students' tactics included flexibility, which allowed them to take

advantage of all opportunities, and the engagement of hard work and self-reflection as they approached fixed goals. The themes that include both a motivation (the "why") and a tactic (the "how") as manifestations of students' aspirational capital are: find and pivot for opportunities and prestige and staying the course through varied tactics. These motivations and tactics underscore theoretical links to aspirational capital as a feeling and a representation of agency. The motivational themes that do not present a common tactic call attention to students' trusted motivators and their desire to contribute to something greater than themselves. These motivations may lead students to engage but we did not identify, among these findings, shared categories of actions. Instead, students drew on trusted motivators to push them to myriad goals or activities but not always with specific direction. Likewise, the method and specifics of contributions to the greater good varied among participants, largely based on their previous life experience. For marginalized-identity students in STEM, these representations of aspirational capital served them throughout their postsecondary experience.

Each of the four themes contains great variation. Where we were able to recognize sub-themes present for specific demographic groups, we have included this information as, well. The collection of subthemes contributes to a deeper understanding of how aspirational capital differently expressed among participants, adding further nuance to the ways in which students engage their motivations and tactics to achieve them.

For many of the findings, and in many of the participants' words, there are indications of multiple components of CCW at work. The emphasis, here, on aspirational capital reinforces understanding of this component's prevalence as an independent and co-occurring capital for marginalized-identity students. Whether independent or combined with another aspect of the

CCW framework, aspirational capital plays an important role in the experience of STEM and higher education for marginalized-identity students.

Find and Pivot: For Opportunities and Prestige

Students' aspirational capital included flexibility in service to their achievements. While they entered the university with high goals, as opportunities arose in adjacent areas of focus, students pivoted to take advantage of them. This tactic, however, relied on the presence of institutional opportunities. Students' willingness to search for diverse opportunities and shift their plans accordingly reflects CCW's aspirational capital.

Aspirational capital led participants in this study to search for opportunities with meaningful and widely respected benefits. They drew on programmatic reputations and self-confidence to meet their high goals. Sophia, a physics major, identified a pathway to her scholarly interests that included a drive to participate in an invitation-only undergraduate research experience. When asked about her introduction to the topic of interest, she said:

> Honestly, I mostly wanted to just be a part of [the undergraduate research program] 'cause like it's a really good program. . . And my major was physics, so I was like, okay, "Which stream like best applies physics?" It's like, okay, [that one] seemed like the best one to go in regarding my major. (Sofia, F, Physics major)

Sofia, in the instance above, discussed the "really good" or prestigious nature as motivation to participate in a research program. She established her major as fixed and engaged a pivoting tactic to make the most of opportunities and choose an aligned research focus. Intrinsic motivation coupled with available opportunities were key for many marginalized-identity students to engage their aspirational capital. Aspirational capital in the form of opportunity pursuance as a tactic is consistent, if varied, in students' pathways through university.

Another example of adaptation required to meet students' high goals is the case of Gabriel (M, Mechanical Engineering major). He shared how he adjusted his post-transfer plans, based on available institutional opportunity and emergent interests, saying:

> So I was in a part of the dual degree, electrical engineering program. And in that program, you're supposed to do three years at [an 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 [this university], I had to switch to ME [Mechanical Engineering] to get the smart energy scholarship. (Gabriel, M, Mechanical Engineering major)

In the example above, Gabriel details how his pursuit of opportunities—the scholarship program—meant that he made different choices in how to engage with the university. To support himself financially while pursuing his broader educational goal, he changed majors. As with other students, Gabriel highlights that the goal of postsecondary preparation fits under a large umbrella and their pathway through the institution(s) features flexibility in accessing opportunities.

While the concept of seeking opportunities and prestige through shifting directions was common among participants, there was some distinction of focus among different identity groupings. For example, women of all ethnic and racial identities sought these opportunities through diverse experiences. This meant, in some cases, seeking experiences outside their major. Among Asian women, this was manifested in their careful consideration in decision making, which contrasted what some students would take for granted or pursue as part of the status quo. For example, one participant delayed beginning her undergraduate education, straying from a

commonly assumed pathway directly following high school. For Black male participants, major was also not a limiting factor in seeking new opportunities, as evidenced by Gabriel's major change—a tactic that other Black males also engaged. Latinx women extended this flexibility to the post-grad realm, leaving open alternative career and further education routes to be embarked upon after they gained a full understanding of the opportunities available within each.

Staying the Course with Varied Tactics

In the face of systemic barriers and limited access to resources for overcoming them, participants engaged diverse ways of knowing, problem-solving, and perspective shifts—where they could not pursue institutional opportunities that served them, they shifted their own behaviors and approaches. Their adjustments were expected, required, and necessary in contexts with high standards and limited guidance in the hidden curriculum, norms, and culture of STEM fields.

Participants identified deep dedication to learning and understanding of rigorous coursework—this was the course they would stay on for academic success. They sought personal development through persistence and two tactics stood out in this pursuit: self-reflection and "hard work." In some cases, the self-reflection led them to the secondary tactic: "hard work." While self-reflection may be part of traditional developmental processes, as a marginalized-identity individual in the context of STEM education, the expectation bears additional weight. First-generation college, low-income, students of color, and women in STEM face cultural and systemic barriers to their STEM success. In the examples that follow, we share students' self-reflection and "hard work" as key manifestations of their aspirational capital to overcome systemic barriers.

In some cases, self-reflection included a “before and after” aspect. Rashid (M, Mechanical Engineering major) reflected on the challenges of balancing multiple areas of engagement and his academic priorities. Early in his explanation, he suggested that high grades were a guidepost along his path of academic excellence and reflects on change over time. He also highlighted the changes he made to his independent approach to college as he pursued success:

> Throughout the school year, I'll be honest, like this year, my grades weren't as good as they were previous years, like I wasn't excelling as much as I was before . . . One of the reasons is definitely from the classes being more difficult, but also because I'm also in a lot more organizations and I have a lot more responsibilities that I'm having trouble. I'm also the head tutor for the EOP [Educational Opportunity Program] for a few classes, that I have like a lot of other responsibilities outside of classes that I have to attend to . . . One of my biggest focuses this year was trying to see how I could balance those classes and also my other focuses. Sometimes you have to know that it doesn't always work out, and in those situations you would have to know, is there some things that you could drop, or some things that you know that you won't be able to balance out. (Rashid, M, Mechanical Engineering major)

Rashid identified tensions around what it took to be successful, including engagement in varied aspects of the postsecondary experience: clubs, research, and wage-earning work as a head tutor. Once he identified the differences between his previous academic achievement and his current semester, Rashid engaged an independent approach by changing his own tactics and perspectives. In this case, he came to focus on building a balance among responsibilities and adjusting his expectations around engagement. Because of his motivation to excel, he

acknowledged the potential need to accept that things would not work out without dropping others. Rashid identified the need for balance and the factors that interrupted it, using self-reflection as a foundation for making change toward the goal of balance and academic excellence.

While there were diverse changes in practice that supported students' academic efforts, there was also a shared narrative of "hard work" as a necessary tactic in the face of consistent challenges. An important component of the "hard work" narrative, for many students, was also its individualistic nature. Matthew (M, Mechanical Engineering) emphasized the personal responsibility he bore for being successful. When asked about his expectations of success, at the community college and at the R1, Matthew replied:

> No excuses. Just do what I have to do. I fully expect to get all As, regardless of how bumpy or rough a semester is . . . I can't be comfortable and assume every semester is going to be smooth like the other. So I just buckle up for it. That's been primarily when it comes in, you know certain semesters. The time management . . . I create a concrete regimen that I can't break the cycle, I have to keep it that way so that I don't fall behind and slack off or anything. (Matthew, M, Mechanical Engineering major)

Matthew's perspective on many semesters in different institutions highlighted his reflective process of comparison between those that are "smooth" and those that have more challenges. Matthew rooted his persistence in high expectations, as indicated by his "no excuses" perspective and drew on time management and independent hard work (not slacking off) to meet his high standards.

Considering this theme according to demographic identities revealed many shared concepts among STEM students. The pursuit academic excellence through personal growth or

progress, was salient for male and female Asian participants; Latino males engaged tactics to achieve it including self-discipline and constant improvement. College as a learning process, including getting to know their individual strengths and weaknesses, was prevalent among women who did not report their race, Latinx women (who sought enriching experiences as part of this), and Asian men. Relatedly, exploring options to problem solve or contribute to personal development was important for Black men who also identified time management as a challenge to their consistent efforts.

Trusted Motivators

While students manifested aspirational capital by engaging diverse tactics to support their goals, they regularly clarified that their motivation had ties to supportive individuals. Key actors were part of their aspirational capital through confidence-building that bolstered intrinsic motivation. These salient figures—social capital assets—represented belonging to a community of support. Engaging such figures echoed a community-based value (explicit or unarticulated) around extended support networks.

For some students, connections to family members were important motivators. Kevin is a Latinx student who was raised in a multigenerational household. Throughout his interview participation, he was clear that his efforts in postsecondary STEM contexts were largely independent, he approached them with fervor based on motivation from others:

> My mom has a different goal for me and my grandma has a different goal. And the one that … They all impact me in the same way, but the one that impacts me on a daily routine or in a daily way would be my grandma's influence. Where I just know that she's like an older person so she'll be like the first one to go out of my life and that is like a race against life to do well. (Kevin, M, Chemistry major)

In the face of academic or other daily challenges, Kevin drew on the motivation provided by his grandmother in addition to the expectations of his mother. In his case, expectations from one generation included supporting the family in terms of housing and financial stability. The motivation from his grandmother, however, came in her support especially in offers of prayer for Kevin's success.

While trusted motivators in Kevin's life focused on success, some students were also able to draw on experiences with trusted stakeholders and mentors to support their passions. Gisela (F, Chemistry major) credited one such individual at her urban community college:

> I didn't know [this R1] school existed until one of my professors at [the community college]. He always told me I had a great potential. So, he found out about this program through [another faculty member]. He pushed me to, he's like, "You've got to go." So here I am. (Gisela, F, Chemistry major)

Institutional knowledge of the scholarship opportunity, Gisela's motivation, one person's confidence in her abilities, and aspirational capital and pushed her to success. She extended this from the community college level through transferring to a four-year, research-intensive institution. For Gisela and others, connections to faculty and other motivators suggested a sense of community and, within that community, high expectations for students with potential. Despite limited resources, marginalized-identity participants had aspirational capital that was supported through the traditional education hierarchy and the lasting impacts of educators. When authority figures offered support and confidence, students were encouraged to echo that in the form of academic persistence and success; aspirational capital was reflected in this process.

Latinx and Asian male students drew on individuals for motivation in nuanced ways. Asian male students, for example, engaged with faculty around research benefitting from and

learning through these enriching activities. Latinx male participants also identified institutionally based motivators who encouraged them through challenging situations. Moreover, they also cited family members as sources of motivation in a broader sense. This link between familial and aspirational capital exhibited the importance of family values and expectations in supporting student success.

Contributing to Something Greater

Participants often prioritized serving something bigger than their own success. While their university time was focused on individual efforts, many marginalized-identity students were motivated to contribute to family and community wellbeing. Rather than an obligation or a duty, this was a motivation that reflected community orientations that have supported generations of marginalized groups in oppressive systems.

Participants in this study were passionate about improving environmental realities, including through consumer products (e.g., improved batteries), as these realities have global impacts. For some students, it was simple, as with Shawn (M, Environmental Chemistry) when he stated, “I want to just save the planet. Just actually make a big impact and just show the colleges that rejected me that they missed out. That's probably my biggest goal.” Shawn’s engagement of this big goal represents aspirational capital, while his foundational reasoning links more to resistant capital, in proving a point to those that doubted him.

For many other students, however, the motivation of giving back to some greater cause was rooted in positive experiences. In sharing their post-secondary experience and life goals, students referenced multiple communities that had served them before getting to college. Xavier (M, Physics major) named the desire to serve a larger purpose and identified the foundation of this perspective:

> I took a [civics] class for credit about a year ago, so my sophomore year. And I noticed how much of an impact a person could do and how much they could impact the community around them. So, I started getting into it because I want to be able to get more involved and be able to help more people out. Especially because, I know as a kid, I needed people to be involved with me and to help me out. So, I'm trying to be one of those people as well. (Xavier, M, Physics major)

Xavier suggested that dedicating his time to make community impact, on an individual level, became a motivation for his actions. Others drew on experiences visiting family outside the US where reliable access to power and water were not available or linked their passions for contributing to the greater good to their home countries and immigration experiences. Knowing living conditions in the Dominican Republic, Ghana, and other nations shaped participants' pursuit of academic success and long-term goals.

Engagement with student organizations were a tactic for many students who were motivated to contribute to something beyond themselves, this was especially salient for Black participants (male and female). This community care ethic was also prevalent for male Latinx students who engaged in leadership positions in student organizations, volunteering, and other means of supporting their peers' opportunities. Beyond the broad community engagement, Latinx males also identified family as the direction for their motivation to "give back" and linked their personal achievements to decreased financial stress on family members.

Discussion

By investigating student experience, this study offered insight into at least four representations of students' "ability to maintain hopes and dreams for the future, even in the face of real and perceived barriers" (Yosso, 2005, p. 77). The themes detail marginalized-identity

STEM students' motivations, including opportunities, prestige, personal development, and college persistence, in response to trusted figures in their lives, and to contribute to something beyond themselves. Two findings also include the ways students pursue those motivations. In looking for opportunities and prestige, students are willing to pivot on their pathways. To develop as individuals and persist in their education, however, students stay the course and engage diverse tactics to achieve success. In pursuit of these goals, students engaged self-reflection and "hard work" (i.e., expecting difficulty and individual effort). These tactics are individualistic, echoing the broader concept of individual effort and reward in postsecondary education.

The individualistic "how" of participants' pursuit of their goals (in the first two findings) contrasts the final two findings which indicate external motivators and community orientations for marginalized-identity students in STEM fields. This juxtaposition is, perhaps, a mirror of the juxtaposition of cultural experience for marginalized-identity students in postsecondary STEM contexts. For those students who come from collectivist backgrounds, individual effort-individual reward in college—as suggested by individual grades, awards, and expectations—may be a sharp contrast to their previous lived experience. This presence of tactics alongside motivators is a nuance of these findings that reinforces the concept of individual agency as part of CCW and aspirational capital.

The identification of motivations and tactics reinforce aspirational capital's theoretical links to other components of CCW, including navigational capital. Navigational capital, "the ability to maneuver through institutions not created with Communities of Color in mind," (Yosso, 2005, p. 80) is present as students 'find and pivot for opportunities and prestige,' or 'stay the course, vary the tactics' in pursuit of their goals. Pivoting to take advantage of opportunities

and the independent tactics to achieve their goals (e.g., self-reflection and independent hard work) are examples of navigational capital, especially when students are not offered guidance in these realms, but instead work out their pathway on their own. Students' employment of navigational and aspirational capital together suggests the need for deeper investigation of this theoretical intersection.

Other overlaps with CCW components appear in the 'trusted motivators' and 'contributing to something greater' findings. In these, aspirational capital overlaps with social capital, "networks of people and community resources" (Yosso, 2005, p. 79). While drawing on the support of individuals for success, aspirational capital is evident in the direction of students' efforts, and social capital is represented by the individuals who motivate them. When contributing to something greater—community or family—marginalized-identity students link to social capital in that they are goal oriented toward contributing to the resources of their network. Familial capital, a "form of cultural wealth [that] engages a commitment to community well being and expands the concept of family to include a more broad understanding of kinship," (Yosso, 2005, p. 79) is also suggested as an overlapping component among the aspirational capital findings. In participants' motivation to contribute to something beyond themselves, they highlight a dedication to community health and their family's success beyond their individual achievements (or perhaps because of them). Such community-based priorities might link to resistant capital, which "refers those knowledges and skills fostered through oppositional behavior that challenges inequality" (Yosso, 2005, p. 80). Resistant capital may be present in "contributing to something greater" because, to some extent, this finding represents the antithesis of STEM learning environments that prioritize individual success (Espino, 2014; Miriti, 2019; Ong et al., 2018). These overlapping components of CCW reveal that aspirational

capital is tied to many parts of students' life experiences which inform their approaches to determining their goals and diverse manners of pursuing them.

Aspirational capital has a strong presence in the literature, as previous research identifies its role in student experience and success. Researchers regularly explored aspirational capital's ties to persistence, motivation, key stakeholders, and to other components of CCW (Denton et al., 2020). The concept of motivation was common to all of the findings in this analysis, as it was pervasive in previous studies. Likewise, persistence was salient in the first and second findings, as participants continued toward their goals by pivoting between institutional options to access opportunities or choosing alternative personal tactics to support their approach. Finally, key stakeholders were important, in this study and others (e.g., Monarrez et al., 2019; Rincón & Rodriguez, 2020), as members of a broader community to which the participants hoped to contribute. Such connections between the present findings and previous work strengthen the arguments for further engagement of CCW as a collection of assets that serve students pursuing STEM education.

This study's inclusion demographically diverse participants, theoretical focus on aspirational capital alone, and qualitative approach are additional lenses through which to understand marginalized-identity STEM students. These methodological and analytical approaches add depth of understanding to aspirational capital's representations, including by the juxtaposition of tactics and motives. The methods and analysis further support a breadth of understanding of this CCW component's applicability to diverse students.

The findings in the present study connect to previous findings and suggest the need for deeper analysis. Complexities including CCW component overlaps and facets of the themes that differ across identity-groups are areas that merit additional analysis to understand student

experience. The study of specific identity groupings is needed to better understand the "how" (tactics) and "why" (motives) of their STEM postsecondary experiences with reference to specific, shared experiences of marginalization. And, likewise, investigating individual components of the CCW framework within specific disciplines may reveal more about discipline culture through the lens of student experience. Together, such expansions will contribute to a better understanding of marginalization in STEM and the steps that students take to mediate its impacts. From there, stakeholders can investigate the "how" and "why" of their own practices to inform changes in the direction of equity.

While the focus of this study adds depth to the understanding of student experiences in STEM, the foundational reality upon which CCW and CRT are based merits consideration in contextualizing this work. The asset-based perspective of CCW, and these research findings, mask the toxic foundations upon which they are built. One damaging outcrop of aspirational capital may be "John Henryism," a coping method by which African Americans have been found to exert great effort in order to manage the realities of oppression (McGee, 2020; McGee et al.,, 2019). It is linked to higher rates of depression, via exposure to discrimination which was higher for African Americans with more education (Hudson et al., 2015; Pitcan et al., 2018). This coping mechanism reflects navigational capital and resistance capital, alongside the aspirational capital indicated here. The individualistic tactics found among participants in this study hinted at aspects of John Henryism, especially in narratives around hard work. While the asset-based framework of CCW supports students' existing, community-based skills, scholars and stakeholders are responsible for critical reflection on the need for such frameworks and for taking steps to push STEM contexts toward equity. By shifting a culture from one that demands

additional labor and exceptionalism from Black students and others with marginalized identities, there is an opportunity to expand the knowledge, innovation, and success of STEM fields.

Implications for Praxis

The present overview may serve as a launch point for considering manifestations of aspirational capital and actions that practitioners can take to honor its presence. Future research, with more robust samples of identity-based grouping and research design focused on multiple components of students' identities, will benefit from an in-depth analysis of aspirational capital as part of marginalized-identity students' higher education experiences. Together, this expansion will allow for a more nuanced understanding of the ways CCW contributes to the success of marginalized-identity students in STEM.

While more research is needed, change for current students is also important. With an expanded understanding of aspirational capital postsecondary STEM stakeholders can recognize the why (motivations) and how (tactics) of marginalized-identity students. From there, the integration of knowledge built from the lived experiences of students may allow higher education to recraft STEM culture and praxis to serve the whole community, rather than the historically privileged groups.

Creating change in the direction of equity is possible for individuals and communities of STEM educators. The first step in this process is likely to update learning and teaching practices among faculty. Changing practice can include refocusing on knowing students as individuals and making space for their values. This learning about individuals can start with encouraging students to look at their own experiences with STEM concepts outside of class as a thorough and meaningful way to model creativity that drives progress. An alternative, simple approach may include a class "exit ticket" that, on the first day of class, would ask students to share the reason

that they entered the field or enrolled in the class, offering a clear indication of aspirational capital or motivations. Cross-disciplinary partnerships and ongoing professional development around serving diverse students are further opportunities for STEM stakeholders to upend the status quo which continues to exclude nondominant-identity students. This may include linking to campus-based student support services, expanding student-centered teaching, or finding an education-based special interest group within a professional organization. Each of these would expose educators to colleagues who think carefully about diverse student experience in STEM. They would offer a space to discuss the role, value, direction, and sources of aspirational capital that help to keep marginalized-identity students afloat in homogenous STEM environments.

Conclusion

The present analysis of aspirational capital among marginalized-identity STEM students underscores the role of hope for diverse students. The ways that hope manifests—through motivations and tactics—and its prevalence among these students suggests what needs to change in service of equity in higher education. As stakeholders see this component of CCW in play among their students, they have the opportunity to shift from deficit perspectives of cultural capital to asset-based understandings of students' experience.

References

Table 1.

Protocol Titles and Brief Descriptions

Interview Protocol	Brief Description
Transfer support experience: Exploring the theory of action	Prompts designed to understand how the scholarship process aligned to its intended outcomes and student experience.
Communities, belonging, identities, and practice	Prompts designed to understand where students participate in or identify with communities of practice.
Defining the field	Prompts designed to gather students' understanding of the program theme.
Experience a STEM student and a Scholarship Program Participant	Prompts designed to understand students' experience in potentially related communities of practice.
Reflecting on progress and practice	Prompts designed to help students identify areas of challenge and success.
Initial	Preliminary protocols engaged by the original researcher on this grant; not extended throughout data collection after 2 semesters. Questions from these protocols were rolled into the protocols that were engaged in subsequent data collection.
End of Year	

Table 2:

Participant Demographics and Majors

Student Demographics[a]		Chemistry	Mechanical Engineering	Physics	Grand Total
Female		6	5	3	14
Asian		1	1	1	3
Black/African American	Hispanic/ Latinx	1		1	2
No response/ Unknown		1			1
No response/ Unknown	Hispanic/ Latinx	1			1
White		1	3	1	5
White	Hispanic/ Latinx		1		1
White and Asian		1			1
Male		5	5	7	17
Asian		2	1	4	7
Black/African American		1	3	1	5
Black/African American	Hispanic/ Latinx			1	1

Student Demographics[a]		Chemistry	Mechanical Engineering	Physics	Grand Total
No response/ Unknown			1		1
No response/ Unknown	Hispanic/ Latinx	2		1	3
Grand Total		**11**	**10**	**10**	**31**

[a]Participants were offered the opportunity to define their sexual and gender identity without limits; none indicated an identity beyond the present binary.