

Critically Quantitative: Measuring Community Cultural Wealth on Surveys

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Abstract

This study explores the possibility of quantitatively measuring the concept of community cultural wealth (CCW), an asset-based approach to understanding the experiences of students from systemically marginalized racial/ethnic groups, developed by Tara J. Yosso. Grounded in critical race theory, CCW focuses on forms of capital utilized by systemically marginalized populations that are often unrecognized/undervalued by traditional social science research. Most previous studies on CCW have relied on qualitative methods to understand the assets that students from marginalized groups possess. However, quantitative critical methods, or “QuantCrit,” can complement qualitative critical methods by statistically specifying the kinds of assets possessed by students from marginalized populations as a step toward reimagining institutions that elevate the importance of those assets. This paper develops a quantitative scale of CCW to help clarify and refine the concept, while acknowledging the overlaps among and the dynamic nature of the forms of capital emphasized in the original conceptualization. We summarize the preliminary results from a pilot survey of students affiliated with Pacific Northwest Louis Stokes Alliances for Minority Participation (PNW LSAMP) in science, technology, engineering, and mathematics (STEM)¹. Initial findings from exploratory factor analysis are largely consistent with Yosso’s conceptual CCW framework but suggest some important ways in which the framework can be further developed.

Introduction

Much of the research on educational inequality by race and ethnicity has taken a deficits-based approach, focusing on how students who are systemically marginalized based on racial and ethnic status lack the resources valued by the dominant group that contribute to success in education, such as cultural capital [1]. While it is important to highlight stark racial and ethnic inequality that exists, this line of research tends to homogeneously characterize racially and ethnically marginalized students as failing in the education system and does not often pay enough attention to the heterogeneity that exists within racially and ethnically marginalized groups. In recent years, however, there has been an increasing number of studies that employ the concept of community cultural wealth (CCW) proposed by critical race scholar Tara J. Yosso [2] to understand the ability of students from marginalized groups to overcome social-institutional barriers and persist in education. The asset-based CCW framework identifies distinct cultural

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resources nurtured through families and communities that students who are systemically marginalized based on racial and ethnic status possess.

While previous studies on CCW have contributed to rich theory development and exploration of the lived experience of students from marginalized groups, most of them utilize qualitative methods. Given the history of statistical and demographic methods being deeply rooted in eugenics and how statistics continue to be mobilized to uphold and sustain racial inequality in contemporary society [3], the use of qualitative methods is very understandable. At the same time, however, it means that only certain research questions can be answered when researchers studying CCW only utilize certain types of methodology, namely, qualitative methods. Answering recent calls for increased utilization of quantitative methods for examining critical race theory, or “QuantCrit” [4], we argue that it is possible to employ statistics to advance critical race studies.

Another gap in the literature on CCW is that there is little research focusing on subpopulations of students from systemically marginalized groups based on ethnic and racial status, such as students who are racially and ethnically minoritized in science, technology, engineering, and mathematics (STEM). For example, as Samuelson and Litzler [5] show, engineering students tend to utilize two of the six forms of CCW identified by Yosso [2] more frequently than the other four. Studies like this show the academic significance of examining diversity in the use of CCW among students from systemically marginalized racial/ethnic groups. In particular, we argue that it is useful to focus on STEM students in this study because, while students who are racially and ethnically marginalized in STEM fields are as likely to enter STEM majors as their white counterparts [6], the proportions of Hispanic, Pacific Islander, American Indian/Alaska Native, and Black students awarded STEM bachelor’s degrees are lower than that of Asian and white students [7]. Moreover, racial and ethnic inequality in persistence to STEM degrees is more pronounced than in non-STEM fields [8]. Research shows that careers in STEM fields have the potential to bring high income [9], and it is socially significant to focus on STEM education in seeking ways for students from racially and ethnically marginalized groups to gain upward economic mobility by obtaining a bachelor’s degree in STEM.

Building on these important previous studies, we use a mixed-methods approach to develop a quantitative scale of CCW to gain a broader understanding of the extent to which students from racially and ethnically marginalized groups possess the various dimensions of CCW and are able to activate/access CCW to succeed in STEM fields. In the following section, we review the concept of CCW and the relationship between critical race theory and quantitative methods.

Background

Community Cultural Wealth

Yosso [2, p. 77] defines 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.” Whereas educational scholars have typically conceptualized cultural capital as the cultural resources valued by the dominant group, Yosso argues that the distinct cultural resources of systemically marginalized populations nurtured by families and communities should be recognized.

Yosso [2] specifies six interrelated dimensions of CCW: aspirational, linguistic, familial, social, navigational, and resistant. Aspirational capital is the belief, derived externally from families and internally from students themselves, in the ability to overcome barriers and persist in their education. Linguistic capital is the set of communication skills developed through practicing and switching between different languages or styles of communication. Familial capital is the commitment to family/community and skills for building relationships that are developed within families. Social capital exists as the networks that provide access to instrumental and emotional support for persisting in education. Navigational capital is the ability to locate and utilize the information and support necessary to navigate institutions designed within dominant paradigms. Resistant capital includes knowledge and skills for resistance developed in the context of structural inequalities/social injustice. This can include self-defeating or conformist strategies (carving out space within racialized social institutions) and transformational strategies (working to change racialized social institutions).

Building on Yosso’s work, scholars have conducted qualitative research to better understand CCW and explore how it is utilized in different contexts. For example, Samuelson and Litzler [5] examine the persistence of engineering students of color to find that they utilize navigational and aspirational capital most often. Similarly, there are studies that propose new forms of CCW. For example, Pennell [10] suggests that transgressive capital is utilized as part of queer cultural capital, and Straubhaar [11] suggests that Spanish-speaking students possess linguistic social capital developed through networks rooted in a shared common language.

Quantification of CCW

In addition to qualitative studies of CCW, there is also a small number of previous studies that aim to develop quantitative scales of CCW. For example, Dika et al. [12] developed a nine-item scale to quantitatively measure CCW among underrepresented minority engineering juniors and seniors. Their instrument included one question per type of capital, except for social capital, which has four items (peer network, faculty/staff, on-campus, off-campus). Table 1 shows the cultural wealth instrument developed by Dika et al. [12, p. 4].

Table 1. Cultural wealth instrument used in Dika et al. [12, p. 4]

| Form of capital | Wording of the survey item |
|-----------------|----------------------------|
|-----------------|----------------------------|

| | |
|----------------------|--|
| Aspirational | I can maintain my hopes and dreams for the future, even when confronted with barriers. |
| Linguistic | I have the ability to switch communication styles or languages based on environment (academic and non-academic). |
| Familial | I maintain a connection to my home community and culture. |
| Social-peer network | I draw on connections with peers to be successful in college. |
| Social-faculty/staff | I draw on connections with individual faculty and staff members to be successful in college. |
| Social-on-campus | I draw on connections with campus organizations or offices to be successful in college. |
| Social-off-campus | I draw on connections with off-campus community organizations or agencies to be successful in college. |
| Navigational | I have developed strategies to navigate difficult people and situations at the university. |
| Resistant | I challenge university practices that seem inequitable. |

Based on the mean levels of agreement with each statement, Dika et al. [12] concluded that underrepresented minority students used aspirational, linguistic, familial, and peer social capital more frequently than other forms of capital. While this is an important study focusing on engineering students, their process of developing the items was exploratory in nature. According to Dika et al. [12, p. 3], “the wording of the statements was developed using the descriptions in Yosso (2005).” However, a more rigorous approach to developing survey questions would include a comprehensive literature review, expert reviews, focus groups, cognitive interviews, and pilot surveys [13]. Moreover, their sample includes only 24 African American/Black students and 17 Hispanic/Latino students, while it contains 195 white students.

A study that follows more closely with the standard methodology for survey questionnaire development is one by Braun et al. [14], focused on deaf students. After developing the draft items, they conducted a focus group to receive feedback from STEM faculty members who are deaf. They also conducted a pilot survey distributed via convenience sampling to their network of colleagues. Moreover, they conducted student cognitive interviews (n=2), which allow researchers to probe participant’s thought processes associated with answering questions using the think-aloud technique often used to design survey questions [15]. Finally, a revised survey was distributed, and they collected responses from 58 students who had 71 mentoring experiences (the focus of their study). Based on factor analysis, they found that their theoretical mentoring framework that combines traditional forms of capital and the ones based on critical

race theory includes four underlying factors (being a scientist, deaf community capital, asking for accommodations, and communication access). Although this study is more sophisticated than Dika et al. [12] in that they followed the standard protocol of survey questionnaire development and they used exploratory factor analysis to develop a measure of CCW with multiple questions per conceptual dimension, both studies do not fully address the historical relationship between critical race theory and quantitative methods.

Unlike these two studies, research by Sablan [16] explicitly discusses the epistemological conflict between critical race theory and quantitative methods, which will be reviewed below. In demonstrating the utility of quantitative methods in critical race studies, Sablan [16, p. 187] takes up the concept of CCW and develops a quantitative operationalization of what has termed “nondominant cultural capital scales,” consisting of aspirational, familial, navigational, and resistant capitals. Following measurement theory while aligning with critical race theory, Sablan [16] conducted a review of literature, expert reviews, a pilot survey, and cognitive interviews before collecting data from undergraduate students at Asian American Native American Pacific Islander-serving institutions (n=772). Findings from exploratory factor analysis performed for each form of capital indicate that some items relating to aspirational capital developed within families are cross-loaded and do not empirically fit the latent aspirational capital construct. Also, it is shown that resistant capital includes two conceptually distinct dimensions, labeled as “(1) identification of oppression in society and (2) motivation to transform oppressive structures” [16, p. 195]. Although this study may be considered one of the most comprehensive studies of the development of a quantitative CCW scale, this study only takes up four of the six forms of CCW that Yosso [2] proposed. Also, the majority of the target population is Pacific Islander or Asian American due to the study setting. Moreover, this study does not include any restrictions regarding the major of the students.

Critical Race Theory and Quantitative Methods

One important tenet of critical race theory is that people from minoritized groups are the primary experts on the oppression that they face based on their minority status [17]. This has led to a variety of critical race studies centering “counter-storytelling” that challenges the dominant perspectives on race and racism, because mainstream educational research tends to ignore the voices and stories of people of color [18]. Moreover, surveys such as the census and quantitative methods in general have been used to uphold and sustain racial and ethnic persecution and discrimination [3], [19].

Due to the reasons mentioned above, most previous studies on CCW have relied on qualitative methods [16]. However, we argue that, in addition to qualitative methods, quantitative methods can be used to empirically examine CCW and contribute to the further development of the CCW concept and critical theories more broadly. The development of our quantitative measure of CCW will contribute to ongoing conversations in the field regarding the significance of

quantitative methods if used from a critical race theory perspective [4]. As shown in the previous section, quantitative methods can be useful for refining existing theoretical concepts to help them become more analytically clarified and describe their embeddedness. The movement to use quantitative methods from a critical race theoretical perspective is not the only “quant crit” movement. It is possible to find a version of quantitative methods used from the perspectives of other critical theories such as feminist theory [20], [21] and queer theory [22]–[24]. The current study is part of the broader, ongoing conversation regarding the relationship between critical theories and quantitative methods.

Research Questions

This paper uses the development of a CCW scale to answer the following questions regarding the CCW framework: What does exploratory factor analysis suggest regarding the structure of the CCW scale? Do the results statistically support the six-dimensional structure of CCW as proposed by Yosso [2]? How can these findings help to further specify the CCW framework?

Data and Methods

Our study is conducted in collaboration with the Pacific Northwest Louis Stokes Alliance for Minority Participation (PNW LSAMP), an NSF-funded project to broaden participation of undergraduate students from racial/ethnic groups minoritized in STEM (African American/Black, Hispanic/Latinx/a/o, American Indian/Alaskan Native, Hawaiian/Pacific Islander). PNW LSAMP consists of five four-year universities, Boise State University, Oregon State University, Portland State University, University of Washington, and Washington State University. In addition, College of Southern Idaho, Linn-Benton Community College, Seattle Central College, and Yakima Valley College participate in PNW LSAMP as community college partners. This study began with a literature review of the CCW framework and the few existing survey instruments that attempt to measure CCW as well as a review of critical race theory and its historical relationship with quantitative methods. We then interviewed 11 students across the PNW LSAMP alliance to help inform the development of our CCW scale. Information from the literature review and student interviews informed the construction of the survey instrument. Six of the original 11 students participated in a follow-up cognitive interview, which involved answering probing questions about the clarity and focus of survey questions.

Using the model questions derived from the preparatory studies mentioned above, we piloted our 81-item CCW survey instrument as part of the 2020 annual PNW LSAMP student survey conducted each spring for program evaluation purposes. Appendix A lists the 81 CCW items we asked in the survey. Each subsection in Appendix A constitutes one question in the survey. For all of the questions except for two questions about linguistic capital (see Appendix 1), we use the following wording: “Please indicate the degree to which you agree or disagree with each statement below. [Statement]. Strongly Agree, Agree, Neither Agree Nor Disagree, Disagree,

Strongly Disagree.” The online survey was distributed via email to 6,974 LSAMP-eligible students, who are STEM students identifying as African American, Hispanic, American Indian, and/or Native Hawaiian/Pacific Islander. Among the 945 students who participated in the survey, a total of 660 students consented and participated in the additional social science research portion of the survey. Table 2 shows the demographic characteristics of the 660 survey participants in this study. It should be noted that our questions for race and ethnicity are based on NSF definitions, and a substantial number of students who selected “Other” for the question on race and indicated that they were Mexican, Hispanic, Mexican American, or Latinx/a/o. Of the respondents who selected “Other” for their major, many indicated their specific major including both STEM majors such as environmental science and non-STEM majors such as public health. The target population of the LSAMP program includes not only students who major in STEM but also those who express interest in majoring in STEM fields even though they have not declared a major in STEM yet.

We use exploratory factor analysis to statistically understand the underlying latent structure of CCW. In doing so, we assume that CCW is an observable construct composed of multiple unobservable factors, and we assume that those underlying factors can be approximated by a set of items asked in the survey. Following Yosso’s [2] argument that CCW dimensions are interrelated, we utilize an oblique rotation method (oblimin rotation), rather than an orthogonal method that assumes all factors are unrelated. Because some of the questions about linguistic capital were asked only to those who speak more than one language, we conduct two kinds of analysis: one that includes all students and excludes responses to the multilingual questions and another that includes only multilingual students.

Table 2. Demographic Characteristics of Survey Participants (n=660)

| Characteristics | Frequency | Percentage |
|----------------------------------|-----------|------------|
| Gender | | |
| Woman | 391 | 59.3 |
| Man | 250 | 37.9 |
| Non-binary or Genderqueer | 14 | 2.1 |
| Another gender | 4 | 0.6 |
| Transgender Identity (Yes) | 9 | 1.4 |
| Sexual Orientation Identity | | |
| Heterosexual | 542 | 79.6 |
| Gay or lesbian | 20 | 3.0 |
| Bisexual | 65 | 9.9 |
| Pansexual | 16 | 2.4 |
| Asexual | 6 | 0.9 |
| Queer | 4 | 0.6 |
| Questioning | 13 | 2.0 |
| I do not understand the question | 5 | 0.8 |

| | | |
|--|-----|------|
| Other | 5 | 0.8 |
| Latinx/Hispanic Identity (Ethnicity) (Yes) | 411 | 62.7 |
| Race (multiple answers allowed) | | |
| Black/African American | 117 | 20.1 |
| American Indian/Alaska Native | 78 | 13.4 |
| Native Hawaiian/Pacific Islander | 77 | 13.3 |
| White | 339 | 58.4 |
| Asian | 72 | 12.4 |
| Other | 103 | 17.7 |
| Major (multiple answers allowed) | | |
| Agricultural Science | 15 | 2.3 |
| Architecture | 23 | 3.5 |
| Biological Sciences | 208 | 31.5 |
| Business and Management | 23 | 3.5 |
| Computer and Information Sciences | 63 | 9.6 |
| Engineering | 152 | 23.0 |
| Engineering Technologies | 12 | 1.8 |
| Mathematics | 27 | 4.1 |
| Natural Resources and Conservation | 20 | 3.0 |
| Physical Sciences | 55 | 8.3 |
| Non-STEM major | 48 | 7.3 |
| I do not plan to get a bachelor's degree | 2 | 0.3 |
| Other | 121 | 18.3 |

Results

An important decision in exploratory factor analysis is specifying how many factors to extract. In determining the number of factors, we use parallel analysis and Velicer's minimum average partial (MAP) test. Although these tests are less common than other popular methods to determine the number of factors, such as the Kaiser's eigenvalue > 1 rule [25], research shows that the eigenvalue > 1 rule almost always overestimates the number of factors to extract [26]. The methods we use in this study are recommended as the most accurate procedures by quantitative methodologists [27].

The parallel analysis for the all-student sample suggests that the number of factors should be 13, and the Velicer's minimum average partial (MAP) test achieves a minimum of 0.01 with 10 factors. The initial parallel analysis for the multilingual-student sample suggests that the number of factors should be 12. For this sub-sample, the Velicer's minimum average partial (MAP) test achieves a minimum of 0.01 with 12 factors. Overall, these analyses suggest that there might be more than six dimensions in CCW. We conducted additional analyses, described below, in order to explore the possibility of some forms of capital constituting multiple sub-dimensions.

For the exploratory factor analysis focusing on all students, we set the number of factors as 10, the lowest value obtained from parallel analysis and Velicer's minimum average partial (MAP) test. Similarly, for the exploratory factor analysis focusing on multilingual students, we set the number of factors as 12, the lowest value obtained from parallel analysis and Velicer's minimum average partial (MAP) test. After conducting these two analyses, we examined the alignment between factors identified through our analyses and CCW dimensions identified in previous research. We made the theory-driven decision to reduce the number of factors to eight based on Yosso's original framework [2] and subsequent studies utilizing CCW [12], [14], [16]. We then conducted two exploratory factor analyses for each sample, setting eight as the number of factors to retain. There is no standard threshold for statistically determining the composition of factors. Based on what made sense conceptually, we used a threshold of the factor loadings greater than .40 to assess the suitability of the items. Below, we indicate the eight latent factors (CCW dimensions) we identified and the survey items and associated factor loadings that constitute each dimension:

- All students
 1. Social capital (proportion explained = 0.19)
 - a. I draw on connections with individual faculty to be successful in college (0.62)
 - b. I draw on connections with university staff to be successful in college (0.69)
 - c. I draw on connections with individuals in campus organizations or offices to be successful in college (0.76)
 - d. I draw on connections with individuals in my religious/spiritual community to be successful in college (0.56)
 - e. My peers are a source of academic support (0.64)
 - f. My peers are a source of emotional support (0.59)
 - g. I am part of an academic organization with other STEM students (0.58)
 - h. I have a mentor or mentors (0.59)
 2. Familial capital (proportion explained = 0.18)
 - a. Family values are an important part of my cultural background (0.69)
 - b. I know about my family's cultural heritage/history (0.52)
 - c. My family has a tradition of storytelling (0.43)
 - d. I frequently attend family gatherings (0.50)
 - e. I have role models in my family (0.58)
 - f. I have passed down stories about my family to my younger relatives (0.42)
 - g. My family is very important to me (0.74)
 - h. I maintain a connection to my parents (0.71)
 - i. I maintain a connection to my extended family (0.52)
 - j. I want to make my family proud (0.65)
 - k. My family provides me with emotional support to persist in my education (0.55)

3. Resistant capital (proportion explained = 0.16)
 - a. I believe there are social injustices that affect women (0.91)
 - b. I believe there are social injustices that affect people of color (0.86)
 - c. I believe there are social injustices that affect LGBTQ people (0.85)
 - d. I believe there are social injustices that affect people with disabilities (0.75)
 - e. Students who share my social identities (e.g. gender, race/ethnicity, sexual orientation and gender identity, disability) face discrimination on my campus (0.48)
 - f. I want to create a more just or equitable society (0.70)
 - g. There are injustices that affect people in the neighborhood where I grew up (0.44)
 - h. Completing my STEM degree will help combat stereotypes about people who share my social identities (0.41)
4. Internal-aspirational capital (proportion explained = 0.14)
 - a. I believe that my dreams for my future are possible (0.64)
 - b. I am hopeful for my future (0.70)
 - c. I consider myself as an ambitious person (0.66)
 - d. I maintain my hopes and dreams for the future, even when confronted with barriers (0.74)
5. External-aspirational capital (proportion explained = 0.12)
 - a. My parents inspired me to pursue a college degree (0.45)
 - b. My parents inspired me to pursue a STEM major (0.60)
 - c. My siblings/cousins inspired me to pursue a college degree (0.73)
 - d. My siblings/cousins inspired me to pursue a STEM major (0.80)
 - e. A teacher inspired me to pursue a college degree (0.46)
 - f. A teacher inspired me to pursue a STEM major (0.50)
6. Monolingual capital (ability to communicate) (proportion explained = 0.09)
 - a. I am good at telling stories (0.46)
 - b. I find it easy to talk to people in a variety of social positions (0.50)
 - c. I have the ability to switch how I communicate based on environment (academic and non-academic) (0.53)
 - d. People find it easy to talk with me (0.54)
7. Family encouragement/expectations (proportion explained = 0.07)
 - a. My family encourages me to persist in my education (-0.46)
 - b. There's an understanding within my family that I will complete my bachelor's degree (-0.48)
8. Monolingual capital (creative expression) (proportion explained = 0.06)
 - a. I am a visual artist (0.48)
 - b. I am a poet (0.49)
 - c. I am a dancer (0.43)

- Multilingual students

1. Social navigational capital (proportion explained = 0.20)
 - a. I draw on connections with individual faculty to be successful in college (0.41)
 - b. I draw on connections with university staff to be successful in college (0.51)
 - c. I draw on connections with individuals in campus organizations or offices to be successful in college (0.46)
 - d. I draw on connections with individuals in my religious/spiritual community to be successful in college (0.46)
 - e. My peers are a source of academic support (0.41)
 - f. I have a mentor or mentors (0.39)
 - g. Even when presented with obstacles, I am able to find the resources I need on campus (0.57)
 - h. I have developed strategies to deal with difficult people at the university (0.61)
 - i. I have developed strategies to navigate difficult situations at the university (0.70)
 - j. I take advantage of the academic opportunities that I am presented with (0.54)
 - k. I ask questions in class and participate in class discussions (0.50)
 - l. I feel comfortable asking questions when necessary (0.57)
 - m. I feel comfortable sharing personal challenges I'm facing in order to seek help (0.57)
 - n. I am confident searching online for information about college resources (0.52)
 - o. I am able to plan ahead to realize the goals I set (0.48)
 - p. I am good at time management (0.43)
2. Resistant capital (belief in injustices) (proportion explained = 0.15)
 - a. I believe there are social injustices that affect women (0.87)
 - b. I believe there are social injustices that affect people of color (0.84)
 - c. I believe there are social injustices that affect LGBTQ people (0.83)
 - d. I believe there are social injustices that affect people with disabilities (0.74)
 - e. Students who share my social identities (e.g. gender, race/ethnicity, sexual orientation and gender identity, disability) face discrimination on my campus (0.48)
 - f. I want to create a more just or equitable society (0.68)
 - g. There are injustices that affect people in the neighborhood where I grew up (0.46)
3. Familial capital (proportion explained = 0.14)
 - a. Family values are an important part of my cultural background (0.55)
 - b. I know about my family's cultural heritage/history (0.54)
 - c. My family has a tradition of storytelling (0.44)
 - d. I frequently attend family gatherings (0.42)
 - e. I have role models in my family (0.46)

- f. I have passed down stories about my family to my younger relatives (0.40)
 - g. My family is very important to me (0.67)
 - h. I maintain a connection to my parents (0.64)
 - i. I maintain a connection to my extended family (0.56)
 - j. I want to make my family proud (0.52)
 - k. My family provides me with emotional support to persist in my education (0.52)
- 4. Social aspirational capital (proportion explained = 0.13)
 - a. I always assumed that I would go to college (0.42)
 - b. My family encourages me to persist in my education (0.51)
 - c. There's an understanding within my family that I will complete my bachelor's degree (0.50)
 - d. My parents inspired me to pursue a college degree (0.55)
 - e. My parents inspired me to pursue a STEM major (0.65)
 - f. My siblings/cousins inspired me to pursue a college degree (0.66)
 - g. My siblings/cousins inspired me to pursue a STEM major (0.64)
 - h. A teacher inspired me to pursue a college degree (0.44)
 - i. A teacher inspired me to pursue a STEM major (0.52)
 - j. A family member or members have taught me lessons that I can use in my schooling (0.43)
 - k. I have siblings/cousins who have provided me with information about college (0.41)
- 5. Multilinguistic capital (proportion explained = 0.12)
 - a. It's easy for me to switch between languages (0.47)
 - b. Knowing more than one language has helped me understand academic concepts (0.52)
 - c. I have used a language other than English to explain academic concepts to peers (0.57)
 - d. As a child, I was often called upon to translate for my parents or other adults (0.63)
 - e. I have formed community with other students based on our shared language (0.65)
- 6. Monolingual capital (creative expression) (proportion explained = 0.10)
 - a. I am a visual artist (0.51)
 - b. I am a poet (0.60)
 - c. I am a musician (0.49)
 - d. I am a dancer (0.57)
 - e. I am good at telling stories (0.57)
 - f. People find it easy to talk with me (0.42)
- 7. Self-aspirational capital (proportion explained = 0.08)

- a. I believe that my dreams for my future are possible (0.61)
 - b. I am hopeful for my future (0.67)
 - c. I consider myself an ambitious person (0.46)
 - d. I maintain my hopes and dreams for the future, even when confronted with barriers (0.60)
- 8. Resistant-aspirational capital (proportion explained = 0.08)
 - a. I see myself pursuing a career in STEM (0.52)
 - b. I need to complete my degree so that there can be more people like me in STEM fields (0.64)
 - c. I can be a role model for other students from similar backgrounds (0.40)
 - d. Completing my STEM degree will help combat stereotypes about people who share my social identities (0.58)

Overall, several of our initial findings are consistent with Yosso's CCW framework but suggest some important ways in which the framework can be further developed to reflect the experience of our survey participants. First, our findings suggest that aspirational capital consists of three sub-dimensions: external-aspirational capital is encouragement and motivation provided by family and other close connections, internal-aspirational capital is internal drive and motivation to persist, and resistant-aspirational capital is the drive to succeed in order to serve as a role model for other students who share similar backgrounds.

Second, we find that Yosso's concept of navigational capital is very closely intertwined with social capital and does not manifest as its own distinct form of CCW. It is likely that students' ability to navigate educational institutions is largely derived from the instrumental support provided through their social networks.

Third, we find that linguistic capital can be understood as two distinct dimensions: multi-linguistic capital and mono-linguistic capital. Most CCW researchers, including Yosso, have primarily discussed linguistic capital as the skills and knowledge developed by multilingual students acting as "language brokers" [28]. However, Yosso's CCW framework allows space for exploring other forms of communication aside from language, and some researchers have interpreted it more broadly in a way that can be extended to monolingual students. For example, Dika et al. [12, p. 2] define linguistic capital as "[t]he ability to switch communication styles or languages on the basis of the environment (e.g., academic and non-academic)." Our analysis suggests that multi-linguistic capital and mono-linguistic capital are two separate constructs, and that the elements of mono-linguistic capital are further aligned with two sub-dimensions: the ability to code-switch/communicate with a variety of audiences and the ability to express oneself creatively.

Discussion and Next Steps

While this study is still in its early stage, the findings from our analysis suggest some important ways in which the framework can be further developed by using quantitative methods. In subsequent analyses, we plan to remove survey items that do not contribute to any forms of capital and conduct additional exploratory factor analyses with different numbers of factors to further refine the quantitative scale of CCW suggested by the current analysis. We are also considering an engineering-specific analysis that we would like to conduct when we have more data from future years of fielding the survey. Similarly, we plan to conduct further analyses within sub-sections of the data to examine whether the underlying structure of CCW holds across intersecting identities. Finally, we have plans to develop our discussion regarding challenges and potential of the use of quantitative methods from a critical race theory perspective. We hope that our quantitative scale of CCW generates many studies that illustrate the possession and activation of CCW among students who are marginalized based on racial and ethnic status and offer insights about how educational institutions can support and promote those distinct forms of capital.

Positionality

As researchers, it is important to not disregard our responsibility for developing and refining our criticality as researchers. Milner (2007) suggests researchers do the following to work through the "seen, unseen, and unforeseen dangers in the practice of their inquiry: researching the self, researching the self in relation to others, [engaging in] reflection and representation, and shifting from self to system" (p. 394-395). In short, this includes engaging in ongoing critical race and cultural self-reflection, negotiating interests between ourselves (collectively and individually) and the community we work in to assure our interests do not overshadow theirs, ensuring there is shared representation of perspectives between ourselves and the community, and viewing research as having systemic implications.

(Author 1) As a non-disabled cisgender non-heterosexual Japanese man born to a lower-middle-class family in Japan, a country in which 97.7% of the total population are Japanese, I bring particular perspectives and assumptions to my research activities. As such, I acknowledge that my research is always incomplete and partial. Some of my social characteristics provide me with privilege, while other characteristics marginalization, and this may vary based on the social-institutional contexts of where I am located, such as living in Japan as a Japanese who speaks Japanese as the first language and living in the United States as an Asian who speaks English as the second language. Using my positionality, my research projects aim to decenter universalized knowledge produced in the studies undertaken in the particular socio-cultural contexts of Western societies and offer an alternative understanding based on a non-Western perspective. I am committed to using my privilege such as being a cisgender man, my experience of marginalization such as being non-heterosexual, and my socially constructed status as the majority in one setting and a minority in another setting to describe, explain, and disrupt systemic racism and other systems of oppression across societies.

(*Author 2*) As a middle-class, able-bodied, White, cisgender woman, I bring certain perspectives and assumptions to my work related to dismantling systemic racism and other forms of oppression both within STEM and in the world more broadly. It is important to acknowledge the ways that these perspectives, shaped by both my background and my social identities, influence my perception of the root causes, consequences, and strategies for addressing inequity in STEM education. My race and gender have afforded me the ability to enter and move through spaces without being perceived as a threat. My class has afforded me access to social capital and high-quality formal education, and the privilege of never fearing that I'd lack any of the essentials I need to survive. My upbringing in a "liberal" family within a politically and culturally conservative region of the country motivated my commitment to social justice but exposed me to a very narrow view of what social justice entails. My knowledge about systems of oppression and understanding of critical theoretical frameworks for interpreting our social world have expanded through engagement with activism and learning about oppression and social inequality within the context of academia, at both a small women's college and a large research university. However, my perspective lacks knowledge gained from lived experience as a member of a marginalized group. I believe that all intellectual pursuits are value-laden, and I approach my work with the intention to use my positions of privilege to challenge White supremacy and contribute to building a more just world. In doing so, I acknowledge the risk that my own blind spots and persistent biases could surface in my research, and invite continued discussion of research findings and their implications with this in mind.

(*Author 3*) As a middle-class white cisgender heterosexual able-bodied (for now) woman, I bring certain perspectives and assumptions to research and evaluation work. My class has assisted me in gaining a university education. My university education introduced me to feminist and anti-racist concepts that have informed my commitment to social justice. My race has granted me the privilege of not increasing my cognitive load when I interact with others in the university. My gender is usually non-consequential in my work, it has sometimes resulted in missed opportunities and changes in the ways others work with me. It has sometimes decreased my feelings of safety in broader society. I understand that my reading and listening and feeling the experiences of others will never let me fully understand the lived experiences of people with marginalized identities. I am committed to doing work that pushes boundaries that will result in societal change to improve justice for systemically marginalized people.

(*Author 4*) Linda Tuhiwai Smith (1999) states research is "not an innocent or distant academic exercise but an activity that has something at stake and that occurs in a set of political and social conditions" (p. 5). I am deeply committed to social and political action to improve the educational and overall outcomes of people marginalized by race, gender, language, class, ability, and other intersecting identities. I am aware that my lived experiences as a middle-class, able-bodied, cisgender, and Afro-Panamanian male influence my worldview. While the socioeconomic class I was raised in has afforded me certain privileges, I have seen and felt the pernicious effects of being a Black man in a white supremacist society. My lived experiences have galvanized my

commitment to justice and equity in my scholarship. I use my privilege as a researcher to focus on the ways in which people of color become free in a system that operates to oppress them.

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Appendices

Appendix A. CCW items used in this study

Aspirational capital

I believe that my dreams for my future are possible

I am hopeful for my future

I consider myself an ambitious person

I see myself pursuing a career in STEM

I maintain my hopes and dreams for the future, even when confronted with barriers

I always assumed that I would go to college

My family encourages me to persist in my education

There's an understanding within my family that I will complete my bachelor's degree

My parents inspired me to pursue a college degree

My parents inspired me to pursue a STEM major

My siblings/cousins inspired me to pursue a college degree

My siblings/cousins inspired me to pursue a STEM major

A teacher inspired me to pursue a college degree

A teacher inspired me to pursue a STEM major

Linguistic capital

I am a visual artist

I am a poet

I am a musician

I am a dancer

I am good at telling stories

I have an easy time memorizing things

I have a strong attention to detail

I find it easy to talk to people in a variety of social positions

I have the ability to switch how I communicate based on environment (academic and non-academic)

People find it easy to talk with me

Q. Do you speak more than one language? [Yes, No]

Q. What languages do you speak in addition to English? [Write in] (only for multilingual students)

It's easy for me to switch between languages (only for multilingual students)

Knowing more than one language has helped me understand academic concepts (only for multilingual students)

I have used a language other than English to explain academic concepts to peers (only for multilingual students)

As a child, I was often called upon to translate for my parents or other adults (only for multilingual students)

I have formed community with other students based on our shared language (only for multilingual students)

Familial capital

Family values are an important part of my cultural background

I know about my family's cultural heritage/history
My family has a tradition of storytelling
I frequently attend family gatherings
I have role models in my family
A family member or members have taught me lessons that I can use in my schooling
I have passed down stories about my family to my younger relatives
My family is very important to me
I maintain a connection to my parents
I maintain a connection to my extended family
My family needs me to help them financially
I feel that I need to do well in school to help my family in the future
I want to make my family proud
My family provides me with emotional support to persist in my education
To me, the term 'family' includes people within my broader community
I maintain a connection to the community where I grew up
I want to improve the well-being of my community
I have people that I consider family on my campus

Social capital

I draw on connections with individual faculty to be successful in college
I draw on connections with university staff to be successful in college
I draw on connections with individuals in campus organizations or offices to be successful in college
I draw on connections with individuals in off-campus community organizations or agencies to be successful in college
I draw on connections with individuals in my religious/spiritual community to be successful in college
My peers are a source of academic support
My peers are a source of emotional support
I am part of an academic organization with other STEM students
I have siblings/cousins who have provided me with information about college
I have a mentor or mentors

Navigational capital

Even when presented with obstacles, I am able to find the resources I need on campus
I have developed strategies to deal with difficult people at the university
I have developed strategies to navigate difficult situations at the university
I take advantage of the academic opportunities that I am presented with
I ask questions in class and participate in class discussions
I feel comfortable asking questions when necessary
I feel comfortable sharing personal challenges I'm facing in order to seek help
I am confident searching online for information about college resources
I am able to plan ahead to realize the goals I set
I am good at time management

Resistant capital

I believe there are social injustices that affect women

I believe there are social injustices that affect people of color
I believe there are social injustices that affect LGBTQ people
I believe there are social injustices that affect people with disabilities
Students who share my social identities (e.g. gender, race/ethnicity, sexual orientation and
gender identity, disability) face discrimination on my campus

I want to create a more just or equitable society

There are injustices that affect people in the neighborhood where I grew up

I challenge university practices that seem unjust

I speak up when I see discrimination or bias

I need to complete my degree so that there can be more people like me in STEM fields

I can be a role model for other students from similar backgrounds

Completing my STEM degree will help combat stereotypes about people who share my social
identities

I'm involved in conversations about increasing equity on my campus

I participate in identity-based clubs or organizations (such as Black Student Union, LSAMP,
Multicultural Center, NSBE, oSTEM, SACNAS, SHPE, SWE, TRIO, etc.)
