

Introducing the C2West Framework for Analyzing Assets of Black Undergraduate Students in Engineering

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Abstract

Asset-based theories explain how people can apply their talents and skills to thrive in diverse environments. When applied to engineering education, these theories can highlight the unique strengths of students of color that help them succeed in college and beyond. An asset-based framework allows both students and instructors to see the potential in students in ways that were previously overlooked or unexplored.

This paper combines one asset-based framework and a powerful contextual theory to highlight the assets of Black students in engineering. First, Yosso's Community Cultural Wealth (CCW) framework examines familial, linguistic, aspirational, resistant, navigational, and social capital. Second, Bronfenbrenner's Ecological Systems Theory (EST) describes the relationships that surround an individual as a set of systems that influence the individual in different ways. We combine the CCW and EST frameworks, to develop the C²WEST framework. This new framework can be used explore the experiences and strengths of Black students in engineering and the contexts that best describe those strengths. The various levels of influence included in EST will be used as a tool for describing the proximity of the assets to the individual as described by CCW. We present an illustrative example to demonstrate the power of combining these two frameworks.

We posit that synthesizing these frameworks provides researchers with unique opportunities to analyze interviews based on the type of capital and the impact the particular capital could have on the individual's engineering journey. In addition to creating a unique way to analyze the experiences of Black engineering students, we anticipate the merged frameworks could be used to help students of Color realize the strengths they bring to the classroom. By identifying their assets, students could feel more empowered in engineering by recognizing the unique strengths they possess. We hope the tool will be used to help students realize their own strengths and for faculty and administrators to further realize how to support students.

Keywords: community cultural wealth, ecological systems theory, asset framework

Introduction

Deficit narratives hold historically marginalized students solely accountable for educational outcomes as a result of inequities and challenges they encounter in life [1]. These narratives fail to recognize how systemic issues within institutions perpetuate unjust structures. Researchers agree there are several negative impacts of deficit narratives including: reinforcing a blame-the-victim orientation, ignoring systemic oppression, and reinforcing inequitable systems. [1] – [4].

However, researchers can choose to view historically marginalized students from an assets-based lens as opposed to a deficit lens. Assets-based approaches focus on skills that students draw from the lived experiences and bring into higher education [5]. In particular, the asset-based framework of Community Cultural Wealth (CCW) theory centers around the strengths and talents that students of color enact in educational settings [6]. Historically marginalized students possess immense cultural wealth that supports them through their undergraduate engineering journeys. In this study, we focus our efforts on the different positive attributes that engineering students of Color bring to their classrooms and build upon those strengths rather than focusing on the systemic and individual struggles the students face. Ecological frameworks can be used to highlight an individual's interaction with their environment(s) to organize sources of influence and their proximity to the individual [7]. Sources of influence can impact students in different ways depending on the proximity of the influence to the individual [7]. We use Bronfenbrenner's [8] Ecological Systems Theory to contextualize and describe the settings in which cultural wealth is enacted and their proximity to the student.

In this paper, we combine the theories of Community Cultural Wealth and Ecological Systems Theory to create a novel framework, Community Cultural Wealth Ecological Systems Theory (C²WEST). As an asset-based framework, we contend that C²WEST can provide contextualized information on the strengths of Black engineering students. We use C²WEST to explain the scope, proximity and influence of Black students' relationships and the application of the skills they learned from their communities to their college pursuits.

We address the following research question: How can combining CCW and EST help explain the experiences of Black students in engineering?

Community Cultural Wealth

Community cultural wealth (CCW) is an asset-based approach created using Critical Race Theory (CRT) and was proposed by Yosso [6] to dispute conventional forms of cultural capital valued in white, middle-class environments. Yosso used CRT to expand the idea of traditionally realized cultural capital. She outlines six assets as “a helpful guiding lens that can inform research in Communities of Color” in an attempt to strengthen individuals in these communities [6], p.75. The six assets are aspirational, linguistic, familial, social, navigational, and resistant capital. Aspirational capital is the “ability to maintain hopes and dreams for the future” (p. 77) which fosters an environment that allows students the opportunity to envision themselves in circumstances beyond their present situations. Linguistic capital is the set skills, specifically intellectual and social, that students gain through the ability to communicate in multiple languages or language styles. Familial capital is the familial support and past cultural knowledge given to an individual which also includes a larger understanding of family, such as extended family and close friends. Social capital is defined as “networks of people and community resources” [6], p. 79, such as contacts within the community that could lead to job opportunities. Navigational capital pertains to the skills required to maneuver through institutions that are not created by or with Communities of Color in mind. Resistant capital is concerned with the

“knowledge and skills fostered through oppositional behavior that challenges inequality” [6] p. 80. This form of capital can be seen when Communities of Color teach their children to demand that they be seen in a positive light and position themselves against negative stereotypes [6]. This form of capital can also be seen in when Communities of Color fight against structural racism, including pushing back against microaggressions. Figure 1 represents our graphical depiction of the six forms of capital an individual can display in Yosso’s CCW model. The individual at the center of Figure 1 is the Black Undergraduate engineering student who is using or performing the different types of capital.

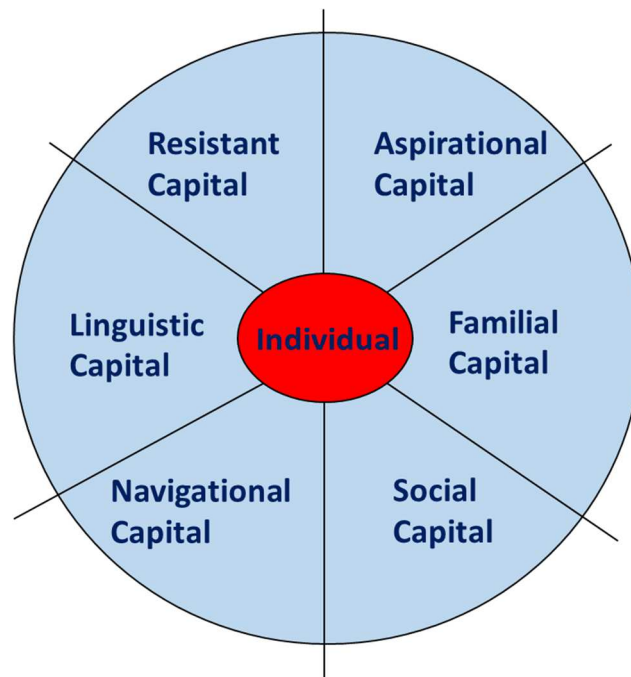


Figure 1. Yosso’s Community Cultural Wealth Model

To formulate CCW, Yosso, a professor of Chicana/o Studies, used multiple theories including Internal Colonial model, Marxism, Chicana and Black feminisms, and cultural nationalism [6]. CCW has been used in multiple ways to analyze the assets of individuals belonging to different communities. Her work has been extended to look to the different forms of CCW held by students of Color. For example, the assets of CCW were examined in Latina/o students using multiple focus groups of teachers, counselors, parents, and superintendents to identify how prepared the students were for college and who felt responsible for preparing them for the multiple challenges they can face in various universities [9]. In a related study, CCW was used to study how Latina/o parents felt they had contributed to the capitals held by their children [10]. The authors found that aspirational capital was the most common capital imparted to children from their parents. Finally, CCW has also been used to explore writing counternarratives to describe Latina/o experiences [11]. In this work, a teacher used CCW as a framework to inform culturally relevant pedagogy for her students. The teacher led her students through the different CCW capitals and how they contributed to the classroom from a CCW lens.

Ecological Systems Theory

Ecological systems theory (EST) is a developmental theory that describes relationships between an individual, their environment, and the ever-changing interaction between the two [8]. The original theory contains four levels nested around an individual with a fifth layer added later. These four original levels are the microsystem, mesosystem, ecosystem, and macrosystem. The microsystem contains the direct settings of the individuals, for example, the home or the classroom. The mesosystem contains the individual and two systems where the person has a direct influence, such as a classroom and home or the workplace and family. The exosystem contains the individual and at least two systems, where the person is not directly present in one of them, such as a conversation about a student between their parent and teacher. The macrosystem represents the broader cultural or subcultures that affect the individual. The chronosystem, which Bronfenbrenner [12] added to the model later, represents changes among the different systems over time, including in the environments and for the developing person [13], [14]. In Figure 2, we conceptualize Bronfenbrenner's theory as a set of concentric circles around the individual.

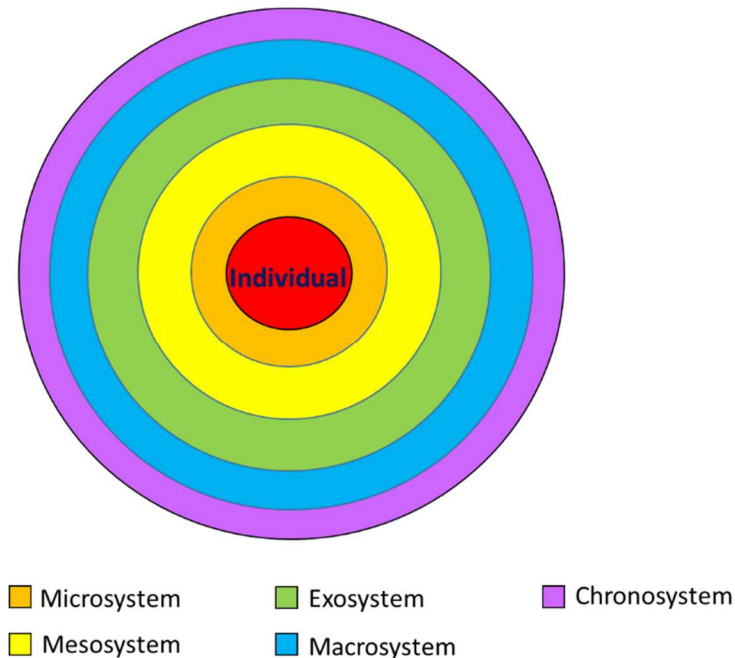


Figure 2. Bronfenbrenner's Ecological Systems Theory

Though EST was created to better explain and understand human development [8], the framework has been used to analyze multiple situations, such as understanding access and impediments to success for Doctor of Physical Therapy (DPT) students [15]. The researchers compared White students and students of Color using a mixed methods approach to observe students' definition of success along with the proximal distances of both positive and negative influences. Fish and Syad [16] used the EST framework to identify the strengths of Native American students and the systemic and structural problems within higher education that impacted their experiences. The authors concluded that it is imperative that institutions value the

“cultural values, traditions, and beliefs of Native American students” (p. 400) to aid students to continue in higher education. They also mention that it is important for institutions to recognize the differences of Native American cultures and note potential tribal differences as they move to enact changes. Finally, McLindon [7] used EST to examine the different barriers that exist for part-time students in higher education with an emphasis on how the different layers of EST are related and how the layers can be used to promote equal opportunities for part-time students.

Community Cultural Wealth Ecological Systems Theory (C²WEST)

In this paper, we have combined Community Cultural Wealth and Ecological Systems Theory to formulate C²WEST, a novel asset-based contextual theory for better capturing experiences of Black students in engineering. Through exploring the different capitals (CCW) that students possess and how the different capitals are related to the student in both proximal and distal ways (EST), we will be better equipped to explore assets students bring to their community and engineering pursuits. C²WEST connects each of different types of capitals included in CCW with the different levels of influence included in EST to create a model that displays not only the type of capital, but the overall proximity of that capital to the student. Figure 3 displays the C²WEST model.

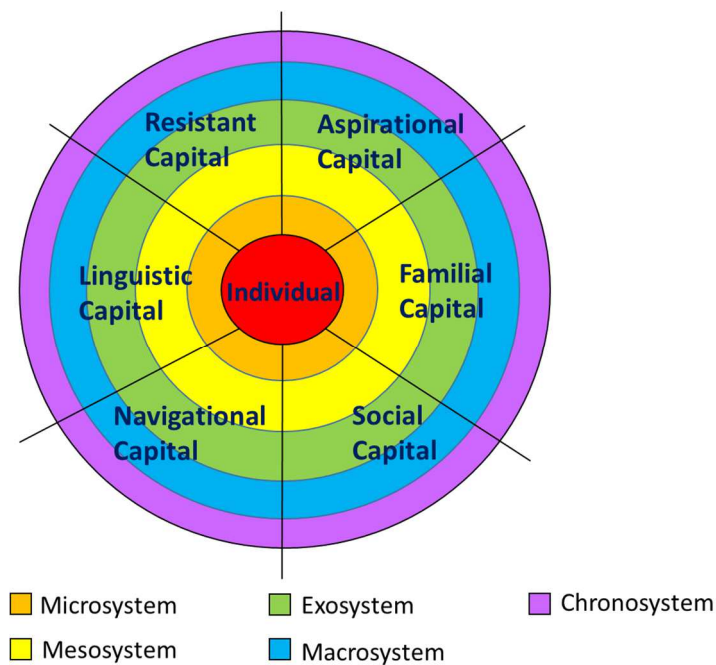


Figure 3. Community Cultural Wealth and Ecological Systems Theory (C²WEST)

Illustrating the C²WEST Framework

To illustrate the C²WEST framework, we draw on an interview conducted as part of a larger qualitative study of Black students in mechanical, electrical, and computer engineering. The

study included 79 interviews at four institutions in the southeastern US. Volunteers were paid \$50 to participate in the 60-120 minute interviews. We have chosen to use “Mikaya’s” story to illustrate how the C²WEST framework might be used to better understand the assets that Mikaya brings to her study of engineering.

Mikaya is a junior first-generation student studying computer engineering at a large, predominantly White institution (PWI). As a high school student, she participated in Project Lead the Way (PLTW), which introduced her to different engineering fields. Through PLTW, she found that she connected with computer engineering. We illustrate how Mikaya’s story fits within the proposed C²WEST framework. Black lettered boxes in Figure 4 represent positions of Mikaya’s various forms of capital in both the CCW and EST frameworks, each of which are described below.

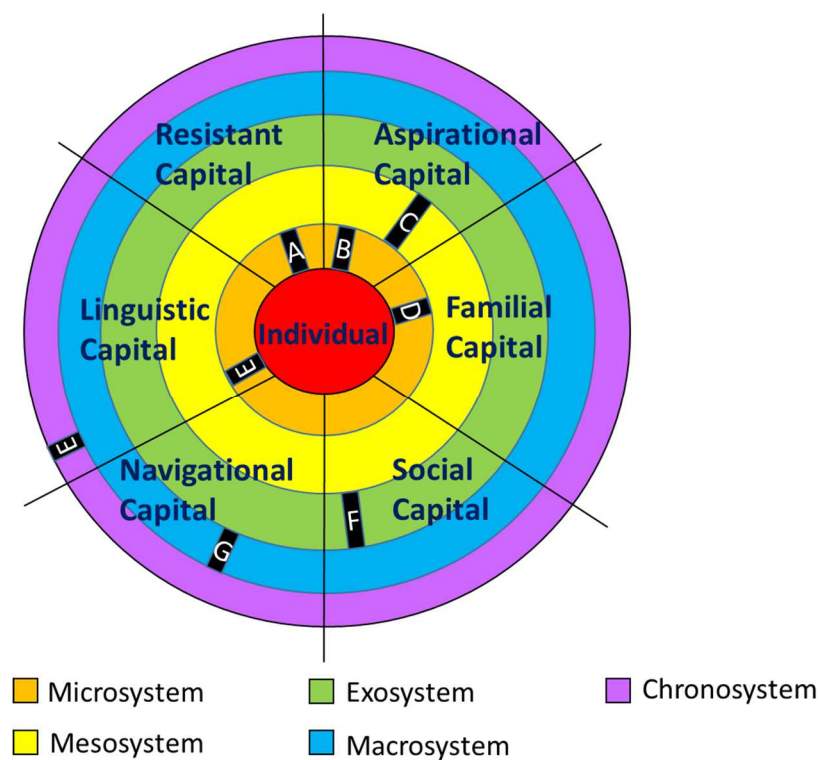


Figure 4. C²WEST Applied to Mikaya’s Experiences

Bar A displays how Mikaya enacts resistant capital at the micro level in the resistant capital area at the innermost orange layer (microsystem). When asked about her strengths in engineering and she responds, “I guess my strength is definitely perseverance. I definitely don't give up when it comes to doing projects or working hard and stuff...” This statement shows that Mikaya has an ability to continue in a difficult major despite opposition. However, the C²WEST ring is the microsystem because the resistance is close to the participant and does not involve multiple and other influences, situations, areas, relationships, or cultures.

Mikaya demonstrates aspirational capital at the black bar marked “B” in the aspirational wedge at the innermost orange layer (microsystem). As she expresses in the interview: “As for me,

since I've been given the opportunity, or the privilege, to go to college and do something with my talents that can cultivate and make something good for myself in the future.” Mikaya mentions the future and positive remarks, however, she does not mention cultural impacts (macrosystem), multiple spaces where she does not exist in at least one (exosystem), multiple spaces where she exists in both (mesosystem), or different points in time (chronosystem). Therefore, “B” is aspirational capital in the micro system because it exists in a single situation, closest to the participant and speaks about the future.

Also, in the aspirational wedge is the bar marked “C” in the second yellow layer, from the individual (i.e., the mesosystem). Mikaya says:

Hopefully, when I graduate, that means something. Not only to me, but my family. Because, coming from a family, the first generation, my mom, my aunts and stuff, they didn't get an opportunity to go to college, or anything. They worked very hard to get the salary, the income, and type of lifestyle that they want. As for me, since I've been given the opportunity, or the privilege, to go to college and do something with my talents that can cultivate and make something good for myself in the future. Not only will it benefit me, but also benefit, my little cousins or my younger friends, siblings. To inspire them to pursue something that they really want.

This quote demonstrates aspirational capital in the mesosystem because Mikaya describes aspirations not only for herself but for her family, cousins, and younger friends, who are individuals in her mesosystem. She wants to do well, meaning she is looking towards the future and do well for the younger people coming after her. The bar marked “C” is placed in the mesosystem because all of the relationships or systems for her aspirations involve her. She is looking towards the future and sets high goals for herself which she believes will also allow the people she knows to rise as well. Therefore, because the multiple microsystems – her friends, her cousins – involve her directly, then this capital belongs in the mesosystem. If the microsystems did not involve her, such as the desire for all Black people to aspire to greater heights because of her own aspirations, then this capital would move to her exosystem.

The black bar marked “D” in the familial capital wedge at the innermost orange layer closest to Mikaya demonstrates familial capital at the microsystem. This is represented by Mikaya explaining how her family supported her to apply to the magnet school she attended after middle school. She also mentions that her family members are “big supporters.” Similar to the capitals above, this form of capital exists in a direct proximity to the individual. It does not contain more than one situation, relationship, or event and neither culture nor change over time is the primary influence.

The black bar marked “E” in the linguistic capital wedge is found at both the innermost orange layer and the outermost purple layer to demonstrate linguistic capital at both the microsystem and the chronosystem levels. Mikaya mentions taking three years of Spanish in high school going from the “beginner to intermediate” levels. This demonstrates a change in time for her Spanish abilities, thus putting the E bar in the chronosystem. She also mentions being in a Spanish club at the collegiate level and wanting to gain “back my vocabulary and pronunciation”

of Spanish, which she was once at an intermediary level meaning that the student has linguistic capital. This capital is also placed at the microsystem level because currently this capital is being used in a club and for her own purposes. However, Spanish is not being used by her in multiple microsystems that either contain her or do not contain her. It is also not being enacted at the cultural level.

Bar “F” in the social capital wedge at the green third layer shows social capital in the exosystem. For Mikaya, this is experienced through studying with multiple people to learn engineering concepts. She mentions in her interview that she studies with her roommate as well as choosing other students based on the shared classes she takes with them. Mikaya is also part of the National Society for Black Engineers (NSBE). Due to the fact that both the students she chooses to study with and her membership in NSBE are situations and systems in that do not contain the student in every situation, the F bar is placed in the exosystem. The bar is in her social capital wedge because both situations allow the student to increase her “networks of people and community resources” [6], p. 79].

Finally, the black bar marked “G” in the navigational capital wedge at the blue fourth layer displays navigational capital enacted in the macrosystem. This is illustrated by Mikaya’s response to a question about the “theme” of their magnet school: “Yeah, our theme was more so math, science, and computer science. So definitely pretty much anybody who was there, they would be in graphic design, computer science...” She goes on to say that students would be more adept at navigating different potential engineering fields if they went to a school where the theme was focused on “math, science, and computer science.” This places the black bar in the navigational capital wedge. Mikaya also mentions an overall theme or culture of the school, which solidifies the placement of the black “G” bar in the blue macrosystem level because the macrosystem involves an overall system or culture in the larger space.

Discussion

Several important lessons can be learned from applying the C²WEST framework to Mikaya’s story. Although there are several examples of different forms of CCW in the various levels of the EST framework, most of the bars (i.e., “A, B, D, and E”) exist in the microsystem. We believe this is because although this student is in her junior year as a computer engineering student, she is still building her network. The microsystem represents systems that are close to the individual, therefore, a junior computer engineering student might have many forms of capital that are close to her and that allow her to succeed in her major. However, this student is likely still building her external networks that would exist in the mesosystem, exosystem, macrosystem, or chronosystem. The mesosystem would require her to have at least two systems with whom she interacts, such as when an advisor advocates for her to one of her professors. The exosystem requires her to be involved in one of the systems, and not involved in the other system, for example, when a student joins a large organization where they interact in some of the organization’s spaces but not in all of them. The macrosystem requires the student to speak about the culture or overall system that affects her or how she plans to change the culture. Finally, the

chronosystem would involve the student speaking about how their capitals have changed. In that instance, it would be common for capitals to appear in both the chronosystem along with another ring. For example, if the student used their friend group to discover different majors, but then described how she tapped into another friend group to decide on a minor that would involve social capital in both the microsystem and the chronosystem.

The results from Mikaya's story could be expected for students at the beginning of their college education. There were less examples of different types of capital in the layers further from the center than we originally expected when reviewing her story. However, upon further inspection, it is clear that a person would need an extensive network and multiple collegiate experiences in order to have capitals that occupied the rings further from the center. The individual may also not be aware of the moment when someone is advocating for them, as this information could come later, or not at all. This is due to the definitions of layers in C²WEST. The mesosystem would involve a person having at least two systems where the person has a direct influence. There are few students who have this type of influence in the beginning of their college studies. Also, the exosystem would involve two systems where the person is not directly present in one of the mentioned systems. Finally, the macrosystem would involve cultural change and the chronosystem would involve change over time. At this stage in her academic career, Mikaya may not have the influence or access to these capitals as someone who is further along in their engineering studies. Therefore, the rings of C²WEST could be drastically different for a person who is further along in their major as well as for students from varying backgrounds.

A student who chose to follow a college path later in life could have an extended network that a student who attended college immediately after high school may not. This would affect the capital that a student would display in their mesosystem, exosystem, macrosystem, and their chronosystem. A student who returns to school would have more time to create, build, and access their different networks that occupy the outer rings of the C²WEST framework.

Future research will examine transcripts from multiple Black engineering students to ascertain if their stories confirmed or refuted the types of capital layer combinations seen in Mikaya's results. Students from different backgrounds at the same academic level (junior) may have a different C²WEST capital map based on their gender, first-time-in-college vs. transfer status, their first-generation college status, and their high school experiences.

Conclusion

We introduced the C²WEST theoretical framework with illustrative examples detailing a female Black undergraduate computer science major's journey at a PWI. This initial application of the C²WEST framework holds promise for expanding understanding about students of Color's experiences in engineering education. Mikaya has an abundance of capital in the microsystem, and several capitals mentioned throughout the different rings of C²WEST. We believe that the multiple capitals mentioned in the microsystem are due to the student being early in the process of building her networks. We also believe that students with different backgrounds would have different amounts of capital in the different rings and might choose to enact different capitals. As

a result of this asset-based framework, we believe we will be better equipped to analyze, understand, and relay the stories of historically marginalized students.

Implications

For researchers interested in using C²WEST, we suggest first looking for the characteristics of strengths and assets that the student brings to their college studies within the framework. This will help researchers define which assets of CCW in C²WEST to consider for the participant. Then, in order to define the ring level of EST within C²WEST, it is key is to decide the number of environments and the amount of the student's involvement. If there is one environment close to the participant, then the strength could be considered part of the microsystem. If the participant has an influence in multiple environments then the strength should be considered for the mesosystem. However, if the participant does not influence at least one of the environments mentioned, the strength should be consider for the exosystem. Finally, if a culture or overarching theme is mentioned, the strength can be considered for the macrosystem and if the participant mentions changes over time then the strength could be considered in the chronosystem.

We believe that while C²WEST provides a strong foundation for explaining the access, location, and influence of capitals in a student's system, a limitation is the possibility for overlap in the types of capital as well as the layers of the rings. There is also the possibility that researchers will not be able to distinguish the different layers from the interviews alone. We strongly recommend the interview protocol be created with the capitals and layers of C²WEST in mind for the most effective results while using the framework.

We plan to continue to expand on the C²WEST framework using additional interviews and examples from other students. The research team will look for students of diverse backgrounds including students who are returning to school later in life, additional first-generation in college students, and multi-racial students. We believe that the unique backgrounds of each student will provide different types of capital that can be seen through the lens of the C²WEST framework. However, it should be stated that while it is important to understand the strengths and assets of historically marginalized students, it is also important to analyze the systemic barriers in place that create obstacles for these students. We hope the framework is used, not as a way to demand the success of historically marginalized students despite systemic barriers, but as a way for college administrators to better learn how they can support students' existing strengths and learn new ways to dismantle systemic barriers for students' success.

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