

WIP: A systematic scoping review of the application of asset-based theoretical frameworks in engineering and science education

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Abstract— This work in progress research paper describes how three theoretical frameworks – funds of knowledge, community cultural wealth, and cultural and social capital – have been used in engineering and science education research. It also highlights the small sample of prior work focused on bridging or combining these frameworks. This paper concludes by describing a systemic scoping review that is underway to compare the research contexts, definitions, and measures used in science or engineering education studies which employ one or more of these frameworks.

Keywords— *funds of knowledge, community cultural wealth, cultural capital, social capital*

I. INTRODUCTION

Although extensive time and funding has been dedicated in recent years to addressing disparities in outcomes for nondominant students in science and engineering, such disparities remain largely unaltered. One potential reason for these lasting gaps is that much of this prior work has been approached from a deficit perspective [1], focused on identifying what nondominant students lack as the reason for outcomes such as their low persistence in engineering education. These deficit-based approaches can lead to ineffective interventions and overlook the entities that are truly lacking, namely the educational systems that are structured to support the success of some students while failing others [2].

In response to the need to improve the systems of engineering education that have historically failed nondominant students, anti-deficit and asset-based theoretical frameworks have been proposed to reframe research and develop educational structures that leverage the resources nondominant students bring to their educations. Funds of knowledge (FoK) and community cultural wealth (CCW) are two of the asset-based theoretical frameworks used most frequently in engineering education research currently. In addition, a third theoretical framework, Bourdieu's concept of cultural and social capital, has been used by education researchers to illuminate the power structures that currently define engineering education and identify what is needed to succeed in engineering as it exists at present.

These three theoretical frameworks – FoK, CCW, and cultural and social capital – each have their own strengths and applications within educational research. Recently, there have been calls from equity-focused education researchers to bridge

these theoretical frameworks to more effectively support the educations of nondominant students [3], [4]. However, the definitions used to describe each framework, the research contexts in which the frameworks are applied, and the methodological tools used to identify or measure each concept in a study all vary widely in the literature. In addition, there has thus far been little attention given to the ways that students bridge their assets and social and cultural capital to succeed in engineering.

In this paper, we give an overview of how FoK, CCW, and Bourdieu's cultural/social capital have been applied in education contexts, broadly, but with special attention to their use in engineering and science education research. We then propose how four asset bridging actions have been operationalized in past research. We conclude by describing a systematic scoping review which is underway to more rigorously explore the prior use of these frameworks, with specific attention to the study designs and research questions where they have been applied, the measures used in such studies, and efforts to bridge two or more of the frameworks [5], [6]. A scoping review is similar to, but distinct from, a systematic review [7], and can be used when researchers are trying to develop an overview of how concepts are used in the literature. Though our primary interest is in engineering education, we look at the fields of both engineering education and science education, as these two fields have different disciplinary histories, training structures, and theoretical biases. Spanning both allows us to better scope how these frameworks are employed by diverse research teams, and in turn, to better develop recommendations for future areas of research within engineering education.

II. OVERVIEW OF THE THREE THEORETICAL FRAMEWORKS

A. Community cultural wealth and funds of knowledge: origins and existing applications in STEM education

Community cultural wealth (CCW) and funds of knowledge (FoK) are two of the most frequently used asset-based frameworks to understand disparate educational outcomes and address them in socially-just ways. Community cultural wealth was first proposed by Yosso as a way to identify and emphasize the strengths and abilities nondominant students – especially students of color – bring to their classrooms, yet which often go unacknowledged in traditional educational systems [8]. CCW is intended to shift the focus away from discussing what

nondominant students lack (or are deficit in) to instead acknowledge the diverse forms of cultural wealth that such students possess. Yosso identifies six forms of CCW: aspirational, navigational, social, linguistic, familial, and resistant capital [8]. Since it was first developed, CCW has been applied widely across many educational contexts, including to explore the experiences of Latina/o and Black students pursuing higher education [9], [10], [11], [12] and graduate school [13], to understand the experiences of teachers and faculty of color [14], [15], and to document the impacts of Latina/o parental involvement in their children's educations [16], [17].

The concept of funds of knowledge was first operationalized by Velez-Ibanez in a study of communities at the US-Mexico border [18]. It was later applied as a way to acknowledge the assets that Mexican American children bring to the classroom [19], [20]. Moll et al. define FoK as the "historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being" [19, p. 133]. Like CCW, FoK emphasizes the assets that students can gain from their home lives, seeing their families as, "containing ample cultural and cognitive resources with great potential utility for classroom instruction" (p. 134). While CCW has been most frequently applied to illuminate the ways that students and professionals of color navigate formal systems (of education, of employment) [2], [21], FoK has been applied within the classroom itself to change pedagogy [22], [23], [24].

In engineering education, both community cultural wealth and funds of knowledge have been used in research studies in recent years. Denton et al.'s systematic review of applications of CCW in STEM education yielded 33 studies that utilized Yosso's framework [21]. The studies identified by Denton et al. include ones that sought to categorize engineering students' CCW and FoK [25], [26] and to explore the dynamics of how different forms of CCW interact with each other in engineering education contexts [27]. Other related work includes Revelo and Baber's study focused on how Latina/o engineering students develop one specific form of CCW, resistant capital, during their engineering studies [28]. Finally, Smith and Lucena identified the FoK of low-income, first-generation students in engineering [29], [30].

B. Bourdieu's analysis of capital: definitions and uses

Bourdieu proposed the notion of capital to explain, "what makes the games of society . . . something other than games of chance" [31, p. 241]. For Bourdieu, capital represents, "the immanent structure of the social world, i.e., the set of constraints, inscribed in the very reality of that world, which govern its functioning in a durable way, determining the chances of success for practices" (p. 242). Bourdieu identified three forms of capital: economic capital; cultural capital (the knowledge, skills and behaviors that an individual acquires from sociocultural contexts); and social capital (social connections and relationships) [31]. Bourdieu argued that one form of capital can usually be converted into another. For example, social capital can often lead to securing a job offer in a desired field, which translates to an increase in economic capital. Foor identified potential cultural capital in engineering as, "knowing how to study, to write a cover letter to go with a resume, or to get a haircut and wear a plain dark suit and white shirt when

interviewing for a job" [32, p. 106]. An example of engineering social capital could be "having a parent who is able to forward their child's resume for a summer internship to a friend working at a company that hires engineers" (p. 106). Others have similarly explored what makes up science cultural capital [33], [34].

Bourdieu divided cultural capital into three forms [31], [35], [36]: embodied cultural capital, which includes "long-lasting dispositions of the mind and body" [31, p. 243] and can be transmitted from one person to another; objectified cultural capital, which takes the form of cultural goods (pictures, books, dictionaries, instruments) and can easily be shared due to its materiality; and institutionalized cultural capital, in the form of academic or other formal qualifications. Bourdieu originally conceived of cultural capital as a way to explain the unequal academic achievement of children from different socioeconomic backgrounds [31]. As academic distinction is defined in terms of a set of cultural and arbitrary norms, it is theorized that students who possess the "right kind" of cultural capital (i.e., the forms valued by schools), and a lot of it, achieve more in the education system [35], [37]. From this perspective, schools are not neutral in their role but rather actively legitimize, value and distribute certain forms of cultural capital, most commonly that of the dominant groups [38].

Social capital is linked to one's network of connections – their "membership in a group" [31, p. 248], which could include a family, tribe, school or political party. A person's social capital, "depends on the size of the network of connections he can effectively mobilize and on the volume of the capital [possessed] by each of those to whom he is connected" (p. 249).

In engineering and science education research, the notion of social and cultural capital has been used as a lens to develop interventions to increase the chances of success of underrepresented minority students [39] and to understand the experiences of engineering transfer students [40]. There have also been attempts to characterize the social and cultural capital accessed by engineering students [25], [41]. Corple et al. found that a culture of positioning biomedical engineering students "on their own" in their professional development at a large, research-intensive university posed barriers to students without "ready access" to specific types of cultural and social capital not provided by their academic program [41, p. 11]. Martin et al. used a quantitative "Name and Resource Generator" instrument to identify the engineering-related social capital that first-generation engineering students accessed before and during their engineering studies [42].

One of the most striking applications of a social and cultural capital framework to engineering education is found in Foor et al.'s use of narrative to highlight the voice of Inez, a low-income, first-generation student [32]. Foor et al. use Inez's story to make visible the interplay between the institutional cultural of an engineering program and Inez's experiences within that program. The authors argue that, in order to change the culture of engineering to make it more inclusive of diverse students, "A requisite step is to examine the underlying beliefs of the dominant culture and their differential impacts on diverse faculty and students, like Inez" (p. 111).

Finally, it is worth noting that some researchers critique the ways that Bourdieu's notion of capital is frequently applied to educational contexts [3], [43], [44], arguing that these applications promote deficit models for understanding disparate educational outcomes among students. While Bourdieu's concept of social and cultural capital is not explicitly anti-deficit, it can be applied to support anti-deficit aims, as it provides a lens to understand and explain the inequities of the current system of engineering education [1], [3]. When used in this way, the framework of cultural/social capital places the blame for disparate educational outcomes not on students, but on broader educational systems and practices; science education research has successfully used cultural/social capital in this way [33]. As described in the following section, bridging asset-based models (like FoK and CCW) and social/cultural capital may be a way to avoid this deficit trap.

C. Calls to bridge funds of knowledge, community cultural wealth, and the forms of capital

In recent years, there have been calls for education researchers and practitioners to bridge the asset-based frameworks of funds of knowledge and community cultural wealth with Bourdieu's concepts of social and cultural capital in order to leverage the strengths of both approaches and improve the educational outcomes of nondominant students [2], [3], [4]. In the introduction to a special issue of the journal *Urban Education* which aims to put these frameworks into conversation with one another, Rios-Aguilar and Neri write, "Without critical examination of the relationship [between FoK, CCW and social/cultural capital], important dilemmas of power and context are left unaddressed, making it difficult to pursue equitable schooling outcomes for minoritized students. [...] The educational pursuit of justice requires both making curricular and pedagogic use of learners' home- and community-based knowledge; and making the codes of power explicit and practicable for minoritized students" [4, pp. 5–6]. Understanding how these theoretical frameworks have been bridged in past engineering and science research and

encouraging such bridging in future studies is one of the primary objectives of the work described here.

Elsewhere, Rios-Aguilar et al. lay out the potential benefits of bridging asset-based frameworks and Bourdieu's notions of capital in educational contexts: "The funds of knowledge approach can benefit from adopting a capital perspective that not only incorporates an examination of power issues within certain contexts, but also emphasizes key processes [...] that can help under-represented students achieve their academic and personal goals. In a similar way, the extensive research on social and cultural capital could benefit from examining the links between power, class, and pedagogical action" [3]. The authors go on to describe how bridging these frameworks can lead to four processes that may advance educational research and opportunities for nondominant students: 1) recognition of students' FoK and CCW, then moving beyond this recognition to 2) transmission of "the tools to begin to transform their resources, and we argue their sociocultural capital and funds of knowledge, into agency and power" (p. 177), 3) conversion of students' and families' funds of knowledge into forms of capital, and finally 4) activation and mobilization of capital, FoK, and CCW [3]. Smith and Lucena have proposed a fifth process, 5) contortion, in which students both *resist* the social and cultural capital valued by a system (such as engineering) and *assimilate* in order to serve their own end goals [45].

The first process, recognition of students' FoK and CCW, has already been explored extensively in science and engineering education (e.g. [30], [46]). In this work, we focus on the four subsequent processes that can follow the initial recognition of students' assets: **transmission**, **conversion**, **activation/ mobilization**, and **contortion**. We refer to these as bridging processes because they are ways that students make connections between their assets and the capital required to succeed in engineering.

In Table 1, we define each of these four bridging processes in more detail and offer examples of how they have been used by other science and engineering researchers in prior work.

TABLE I. DEFINITIONS AND PRIOR USES OF FOUR ASSET-BRIDGING PROCESSES

Bridging process	Definition	How this process has been used by other STEM education researchers
Transmission of assets and forms of capital within students' families, peers, and university networks [3]	Includes all the ways that FoK, CCW, and social/cultural capital are acquired or learned from another person.	Martin and Newton, 2016 – Coding of the CCW and FoK that underrepresented engineering students report as significant [25].
Conversion of students' and families' FoK and CCW into forms of capital [3]	Conversion between resources explicitly valued in an engineering education context (social/cultural capital) and those that commonly go unacknowledged or unvalued. Usually entails an exchange rate [3] which can be quite costly for some students.	Smith and Lucena, 2016 - How LIFG engineering students convert their engineering FoK into social/cultural capital [29], [30].
Activation and mobilization of capital, FoK, and CCW [3]	Moves beyond availability of a resource to its actual utilization to achieve a desired end. Usually accompanied by an awareness of the relevant power dynamics in a given context [3].	Wilson-Lopez & Acosta-Feliz, 2021 – Explored how Latinx youth mobilized their workplace FoK in engineering education [26]. L. Martin, 2014 – Bridged CCW and social/cultural capital in the design of a support program for STEM Latina/o transfer students [47].
Contortion [45]	A process in which students simultaneously <i>resist</i> the capital valued by a system and <i>assimilate</i> to serve their goals [45].	Smith and Lucena, 2022 – Detailed description of how four LIFG students engaged in contortion in their engineering educations [45].

III. SYSTEMATIC SCOPING REVIEW OF THE THEORETICAL FRAMEWORKS

To better understand how these three theoretical frameworks have been employed in science and engineering education, our research team has initiated a systematic scoping review. A scoping review is the best choice for this undertaking because, unlike systematic reviews, scoping reviews are helpful for “mapping the key concepts that underpin a research area” [5, p. 142], which aligns with the objectives of our work. In this section, we describe the scoping review protocol that we have developed.

A. Scoping review questions

The review questions in a scoping review guide the search for relevant papers and the inclusion criteria that determine which sources are included [5]. Our scoping review has four questions:

- 1) What are the common study designs and research contexts in science and engineering education where these theoretical frameworks have been used?
- 2) In studies that employ FoK, CCW, or cultural/social capital, how are these frameworks defined?
- 3) How have two or more of these frameworks been bridged or combined in science or engineering education research?
- 4) How have FoK, CCW, and cultural/social capital been measured in science and engineering education research?

B. Inclusion criteria

We are using the following inclusion criteria in our search:

- FoK, CCW, and/or cultural/social capital should be identified by the authors as one of the primary theories applied in the work.
- The research context should be in science or engineering education.
- We have limited the search to 2005 to 2024, as 2005 marks the date that the newest of these frameworks (community cultural wealth) was first proposed [8].

IV. FUTURE WORK

Our team has begun to develop our search strategy, which has included the development of search terms and preliminary searches in relevant research databases with support from a university librarian. Our next steps in this work are to complete this initial search, remove duplicate papers, and begin to review the abstracts of the non-duplicate papers to determine if they meet our inclusion criteria.

REFERENCES

- [1] S. R. Harper, “An anti-deficit achievement framework for research on students of color in STEM,” *New Dir. Institutional Res.*, vol. 2010, no. 148, pp. 63–74, 2010, doi: 10.1002/ir.362.
- [2] R. C. Neri, L. Zipin, C. Rios-Aguilar, and A. H. Huerta, “Surfacing Deep Challenges for Social-Educational Justice: Putting Funds, Wealth, and Capital Frameworks into Dialogue,” *Urban Educ.*, p. 00420859211016520, May 2021, doi: 10.1177/00420859211016520.
- [3] C. Rios-Aguilar, J. M. Kiyama, M. Gravitt, and L. Moll, “Funds of knowledge for the poor and forms of capital for the rich? A capital approach to examining funds of knowledge,” *Theory Res. Educ.*, vol. 9, no. 2, pp. 163–184, 2011.
- [4] C. Rios-Aguilar and R. C. Neri, “Funds of Knowledge, Community Cultural Wealth, and the Forms of Capital: Strengths, Tensions, and Practical Considerations,” *Urban Educ.*, p. 00420859211016522, May 2021, doi: 10.1177/00420859211016522.
- [5] M. D. J. Peters, C. M. Godfrey, H. Khalil, P. McInerney, D. Parker, and C. B. Soares, “Guidance for conducting systematic scoping reviews,” *Int. J. Evid. Based Healthc.*, vol. 13, no. 3, pp. 141–146, Sep. 2015, doi: 10.1097/XEB.0000000000000050.
- [6] A. C. Tricco *et al.*, “A scoping review on the conduct and reporting of scoping reviews,” *BMC Med. Res. Methodol.*, vol. 16, no. 1, p. 15, Dec. 2016, doi: 10.1186/s12874-016-0116-4.
- [7] Z. Munn, M. D. J. Peters, C. Stern, C. Tufanaru, A. McArthur, and E. Aromataris, “Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach,” *BMC Med. Res. Methodol.*, vol. 18, no. 1, p. 143, Dec. 2018, doi: 10.1186/s12874-018-0611-x.
- [8] T. J. Yosso, “Whose culture has capital? A critical race theory discussion of community cultural wealth,” *Race Ethn. Educ.*, vol. 8, no. 1, pp. 69–91, Mar. 2005, doi: 10.1080/1361332052000341006.
- [9] L. P. Huber, “Challenging Racist Nativist Framing: Acknowledging the Community Cultural Wealth of Undocumented Chicana College Students to Reframe the Immigration Debate,” *Harv. Educ. Rev.*, vol. 79, no. 4, pp. 704–730, Dec. 2009, doi: 10.17763/haer.79.4.r7j1xn011965w186.
- [10] U. Jayakumar, R. Vue, and W. Allen, “Pathways to College for Young Black Scholars: A Community Cultural Wealth Perspective,” *Harv. Educ. Rev.*, vol. 83, no. 4, pp. 551–579, Dec. 2013, doi: 10.17763/haer.83.4.4k1mq00162433128.
- [11] D. D. Liou, R. Antrop-González, and R. Cooper, “Unveiling the Promise of Community Cultural Wealth to Sustaining Latina/o Students’ College-Going Information Networks,” *Educ. Stud.*, vol. 45, no. 6, pp. 534–555, Nov. 2009, doi: 10.1080/00131940903311347.
- [12] N. A. Luna and M. Martinez, “A Qualitative Study Using Community Cultural Wealth to Understand the Educational Experiences of Latino College Students,” *J. Prax. Multicult. Educ.*, vol. 7, no. 1, Apr. 2013, doi: 10.9741/2161-2978.1045.
- [13] M. M. Espino, “Exploring the Role of Community Cultural Wealth in Graduate School Access and Persistence for Mexican American PhDs,” *Am. J. Educ.*, vol. 120, no. 4, pp. 545–574, Aug. 2014, doi: 10.1086/676911.
- [14] R. Burciaga and R. Kohli, “Disrupting Whiteman Measures of Quality Teaching: The Community Cultural Wealth of Teachers of Color,” *Multicult. Perspect.*, vol. 20, no. 1, pp. 5–12, Jan. 2018, doi: 10.1080/15210960.2017.1400915.
- [15] M. A. Martinez, A. Chang, and A. D. Welton, “Assistant professors of color confront the inequitable terrain of academia: a community cultural wealth perspective,” *Race Ethn. Educ.*, vol. 20, no. 5, pp. 696–710, Sep. 2017, doi: 10.1080/13613324.2016.1150826.
- [16] A. Aragon, “Achieving Latina students: Aspirational counterstories and critical reflections on parental community cultural wealth,” *J. Lat. Educ.*, vol. 17, no. 4, pp. 373–385, Oct. 2018.
- [17] C. Larrotta and E. K. Yamamura, “A Community Cultural Wealth Approach to Latina/Latino Parent Involvement: The Promise of Family Literacy,” *Adult Basic Educ. Lit. J.*, vol. 5, no. 2, p. 12, 2011.
- [18] C. G. Velez-Ibanez, “Networks of exchange among Mexicans in the US and Mexico: Local level mediating responses to national and international transformations,” *Urban Anthropol. Stud. Cult. Syst. World Econ. Dev.*, pp. 27–51, 1988.
- [19] L. C. Moll, C. Amanti, D. Neff, and N. Gonzalez, “Funds of Knowledge for Teaching: Using a Qualitative Approach to Connect Homes and Classrooms,” *Theory Pract.*, vol. 31, no. 2, pp. 132–141, 1992.
- [20] C. G. Velez-Ibanez and J. B. Greenberg, “Formation and Transformation of Funds of Knowledge Among U.S.-Mexican Households,” *Anthropol. Educ. Q.*, vol. 23, no. 4, pp. 313–335, 1992, doi: 10.1525/aeq.1992.23.4.05x1582v.
- [21] M. Denton, M. Borrego, and A. Boklage, “Community cultural wealth in science, technology, engineering, and mathematics education: A systematic review,” *J. Eng. Educ.*, vol. 109, no. 3, pp. 556–580, 2020, doi: <https://doi.org/10.1002/jee.20322>.

- [22] A. C. Barton and E. Tan, "Funds of knowledge and discourses and hybrid space," *J. Res. Sci. Teach.*, vol. 46, no. 1, pp. 50–73, 2009, doi: 10.1002/tea.20269.
- [23] J. M. Kiyama and C. Rios-Aguilar, *Funds of knowledge in higher education*. New York, NY: Routledge, 2018.
- [24] G. M. Rodriguez, "Power and Agency in Education: Exploring the Pedagogical Dimensions of Funds of Knowledge," *Rev. Res. Educ.*, vol. 37, no. 1, pp. 87–120, 2013, doi: 10.3102/0091732X12462686.
- [25] J. P. Martin and S. Newton, "Uncovering Forms of Wealth and Capital Using Asset Frameworks in Engineering Education," 2016.
- [26] A. Wilson-Lopez, J. A. Mejia, I. M. Hasbún, and G. S. Kasun, "Latina/o Adolescents' Funds of Knowledge Related to Engineering," *J. Eng. Educ.*, vol. 105, no. 2, pp. 278–311, 2016, doi: 10.1002/jee.20117.
- [27] C. C. Samuelson and E. Litzler, "Community Cultural Wealth: An Assets-Based Approach to Persistence of Engineering Students of Color," *J. Eng. Educ.*, vol. 105, no. 1, pp. 93–117, 2016, doi: 10.1002/jee.20110.
- [28] R. A. Revelo and L. D. Baber, "Engineering Resisters: Engineering Latina/o Students and Emerging Resistant Capital," *J. Hisp. High. Educ.*, vol. 17, no. 3, pp. 249–269, Jul. 2018, doi: 10.1177/1538192717719132.
- [29] J. M. Smith and J. C. Lucena, "How do I show them I'm more than a person who can lift heavy things? The funds of knowledge of low income, first generation engineering students," *J. Women Minor. Sci. Eng.*, vol. 22, no. 3, pp. 199–221, 2016, doi: 10.1615/JWomenMinorScienEng.2016015512.
- [30] J. M. Smith and J. C. Lucena, "Invisible innovators: how low-income, first-generation students use their funds of knowledge to belong in engineering," *Eng. Stud.*, vol. 8, no. 1, pp. 1–26, Jan. 2016, doi: 10.1080/19378629.2016.1155593.
- [31] P. Bourdieu, "The Forms of Capital," in *Handbook of Theory and Research for the Sociology of Education*, Westport, CT: Greenwood Press, 1986, pp. 241–258.
- [32] C. E. Foor, S. E. Walden, and D. A. Trytten, "I Wish that I Belonged More in this Whole Engineering Group: Achieving Individual Diversity," *J. Eng. Educ.*, vol. 96, no. 2, pp. 103–115, 2007, doi: 10.1002/j.2168-9830.2007.tb00921.x.
- [33] L. Archer, E. Dawson, J. DeWitt, A. Seakins, and B. Wong, "Science capital: A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts," *J. Res. Sci. Teach.*, vol. 52, no. 7, pp. 922–948, Sep. 2015, doi: 10.1002/tea.21227.
- [34] S. A. Claussen and J. Osborne, "Bourdieu's notion of cultural capital and its implications for the science curriculum: Cultural Capital and The Science Curriculum," *Sci. Educ.*, vol. 97, no. 1, pp. 58–79, Jan. 2013, doi: 10.1002/sce.21040.
- [35] R. Jenkins, *Pierre Bourdieu*. New York, NY: Routledge, 2002.
- [36] J. Webb, T. Schirato, and G. Danaher, *Understanding Bourdieu*. London: Sage, 2002.
- [37] M. Apple, *Curriculum and ideology*. London: Roudledge & Kegan Paul, 1979.
- [38] P. Bourdieu and J. C. Passeron, *Reproduction in education, society and culture*. Thousand Oaks: Sage, 1977.
- [39] S. M. Ovink and B. D. Veazey, "More Than 'Getting Us Through:' A Case Study in Cultural Capital Enrichment of Underrepresented Minority Undergraduates," *Res. High. Educ.*, vol. 52, no. 4, pp. 370–394, Jun. 2011, doi: 10.1007/s11162-010-9198-8.
- [40] C. Mobley, E. G. Shealy, and C. E. Brawner, "First-generation engineering transfer students: A qualitative study of social and cultural capital," in *2013 IEEE Frontiers in Education Conference (FIE)*, Oct. 2013, pp. 1651–1653. doi: 10.1109/FIE.2013.6685118.
- [41] D. Corple, C. Zoltowski, S. Eddington, A. Brightman, and P. Buzzanell, "What You Need to Succeed: Examining Culture and Capital in Biomedical Engineering Undergraduate Education," in *2019 ASEE Annual Conference & Exposition Proceedings*, Tampa, Florida: ASEE Conferences, Jun. 2019, p. 33556. doi: 10.18260/1-2--33556.
- [42] J. P. Martin, M. K. Miller, and D. R. Simmons, "Exploring the Theoretical Social Capital "Deficit" of First Generation College Students: Implications for Engineering Education," *Int. J. Eng. Educ.*, vol. 30, no. 4, pp. 822–836, 2014.
- [43] K. A. Hinton, "Should We Use a Capital Framework to Understand Culture? Applying Cultural Capital to Communities of Color," *Equity Excell. Educ.*, vol. 48, no. 2, pp. 299–319, Apr. 2015, doi: 10.1080/10665684.2015.1025616.
- [44] S. O'Shea, "Avoiding the manufacture of 'sameness': first-in-family students, cultural capital and the higher education environment," *High. Educ.*, vol. 72, no. 1, pp. 59–78, Jul. 2016, doi: 10.1007/s10734-015-9938-y.
- [45] J. M. Smith and J. C. Lucena, "Literary Contortionists: How Low-Income, First Gen Engineering Students Adapt & Resist to Achieve Literacy," in *The Literacies of Design: Studies of Equity and Imagination in Engineering and Making*, Purdue University Press, 2022.
- [46] V. B. Sellers, J. P. Martin, and M. Seraphin, "A NARRATIVE INQUIRY APPROACH TO COMMUNITY CULTURAL WEALTH OF BLACK MEN IN ENGINEERING," *J. Women Minor. Sci. Eng.*, vol. 28, no. 4, pp. 69–95, 2022, doi: 10.1615/JWomenMinorScienEng.2021038012.
- [47] L. Martin, "The hidden curriculum exposed: How one outreach program bridges cultural capital and cultural wealth for Latina/o community college transfer students," Ph.D., University of California, Los Angeles, Los Angeles, CA, 2014. Accessed: May 26, 2022. [Online]. Available: <https://www.proquest.com/docview/1551196515/abstract/43EE21CBE403404FPQ/1>
- [48] J. P. Martin, S. K. Stefl, L. W. Cain, and A. L. Pfirman, "Understanding first-generation undergraduate engineering students' entry and persistence through social capital theory," *Int. J. STEM Educ.*, vol. 7, no. 1, p. 37, Dec. 2020, doi: 10.1186/s40594-020-00237-0.