

# Towards a Culturally Responsive Design Experience: How Students' Community Capital Contribute to their Design Approach

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**Abstract—** This Research work-in-progress (WIP) presents the preliminary analysis of how undergraduate engineering students incorporate their backgrounds and experiences into their design approach. Like practicing engineers, students draw from their lived experiences to support their design process. This WIP uses Community Cultural Wealth to capture the extent to which local connections and cultural networks (i.e., community capital) influence the design considerations of students from a Hispanic Serving Institution. Preliminary results analyze the design process of three mechanical engineering undergraduate students in their first semester of a Capstone Design course. The students participated in a focus group interview, where they were asked to complete a design task and respond to follow-up questions. This WIP focuses on a community-driven analysis of students' design approach and considerations solely within the focus group interview. This study aims to inform the development of more inclusive and culturally responsive learning environments that enable students to purposefully leverage their backgrounds within their design process.

**Keywords—**Engineering Design, Culturally Responsive Teaching, Capstone Design

## I. MOTIVATION

There is a need for inclusive and culturally responsive and relevant instructional practices in design education [1], [2]. Students bring unique perspectives, dynamic considerations, and unanticipated connections naturally characteristic to design to their design approach. However, the extent to which engineering programs value and foster these elements of students' approach, alongside the values and cultural elements of the discipline, can influence a student's perspective as a designer on what aspects of their disciplinary identity and background should be used to support their design decisions and process. For this study we consider a design approach to be the

process a student goes through to solve a given problem or design task. Beyond what is learned in the classroom, students possess different funds of knowledge and experiences which inform their considerations and approaches to design. However, while these funds of knowledge are present, students may not be purposefully accessing and leveraging them to support their design approach. Many of students' perceptions and values stem from, for example, the culture and experiences socialized by their communities [2]–[4]. Recent studies acknowledge the value of including culturally responsive pedagogies to support students' development as culturally competent and engaged engineering professionals who are better prepared to navigate the socio-scientific and socio-political challenges in the workforce [3], [4]. The multiculturalism and diversity found amongst students and their communities, like any other source of knowledge and expertise, is an asset, and our programs must be well equipped to bring this out. In other words, to better equip students to effectively address the needs of a rapidly evolving and diverse society we must first understand and relate teaching content to the cultural backgrounds of our students. In design education, specifically, where pedagogies are typically flexible to support a wide variety of design projects and approaches, there is an opportune course to critically think and explore the development of students' design approaches as a means to integrate responsive instructional practices into engineering design courses.

Understanding how and to what extent various sources of knowledge influence an individual's design approach is critical to teaching students how to purposefully leverage these sources to create more adaptable, inclusive, and innovative designs. Engineers draw from their lived experiences and backgrounds to support their design approach [5]–[7]. Diverse circumstances, childhood experiences, cultures, and educational backgrounds within a design environment have yielded more innovative,

empathetic, and effective designs [8], [9]. This work-in-progress (WIP) is part of a larger investigation that explores how students incorporate their backgrounds and experiences into their approach to design. This study is situated in a Hispanic Serving Institution (HSI) where there is an abundance of cultures, backgrounds, and experiences amongst the student population. To holistically capture student experiences without diminishing their cultural value, we used an asset-based theoretical framework, Community Cultural Wealth. For this WIP, we primarily explore the extent to which a student's local connections and cultural network (i.e., community capital) inform their design. Overall, this WIP aims to inform the development of more inclusive and culturally responsive learning environments that enable and empower students to leverage their backgrounds as unique strengths within their design experiences.

## II. THEORETICAL FRAMEWORK

To effectively investigate how students bring their backgrounds, experiences, and identities to their design process, we employed the use of Yosso's theoretical framework, Community Cultural Wealth (CCW). Stemming from Critical Race Theory (CRT), CCW shifts the traditional deficit view of communities of color to an assets-based view [10]. In particular, CCW employs the use of several subset lenses, 'capitals', that identify different, non-standardized, components of culture. For example, a marginalized student may not have come from a prestigious engineering high school, but their close relative worked as a mechanic (Community Capital), which may impact how they design the technical components (e.g., arrangement of cylinders) of an engine. Researchers using a deficit lens may have failed to see how the student's family played a role in informing their design, focusing only on their lack of formal engineering exposure. As such, the CCW framework enables researchers to capture an important component of a student's experience and background and give it perspective. CCW has been effectively utilized to characterize and understand the experiences, persistence, and capitals employed by students of color as they pursued their degrees in undergraduate engineering [11][12]. In the remainder of this section, we define the capitals employed in this WIP.

CCW, as described by Yosso, includes 6 different capitals: Aspirational, Familial, Linguistic, Social, Resistant, Navigational [10], [13]. For this WIP, we focused solely on Familial and Linguistic capitals as forms of Community Capital. Familial and Linguistic capitals respectively describe cultural knowledge obtained amongst individuals with a sense of community history, memory, and cultural intuition [10], [14]; and intellectual and social skills obtained through communication via language and style [10], [15]. Together, these two capitals describe the support that a community provides to an individual, and their connection to the community through its history, memory, language, and culture [13]. Future work, stemming from this WIP will examine other forms of CCW capitals seen within the data.

## III. METHODOLOGY

This WIP study was conducted at a HSI. Therefore, it was important to use research methodologies and a theoretical framework that would allow the research team to assess

students' cultures without using standardized techniques that may diminish the significance of their experiences. Community capital, specifically, allowed us to understand the design considerations that participants made due to their cultural upbringing and their relationships with their communities.

With the help of the CCW framework we sought to answer the following research questions:

1. How do students incorporate their backgrounds, experiences, and identities in their design approach?
2. How do students integrate their community capital into a design?

### A. Positionality

All authors are Latinx, with either parents or themselves having been born in a Spanish-speaking country in Latin America. Three grew up in the area where this study took place, and the remaining two authors grew up in culturally similar areas. All authors have or are pursuing undergraduate degrees in engineering. Each has been conducting engineering design education research for at least a year. Four have instructional experience, either as a design faculty, undergraduate teaching assistants, or graduate instructors. Four are pursuing or received graduate degrees focused on conducting engineering education research.

### B. Site and Sample

This study was conducted at a large public HSI in the southeastern United States. Participants were recruited from the biomedical, materials, and mechanical engineering departments where they were enrolled in the first semester of a two-semester long Capstone course.

Participants were recruited through course announcements and faculty or research team recommendations. Each potential participant first filled out a screening survey before being selected. Teams and individuals of varying backgrounds were selected to capture a range of experiences and perspectives. Gift cards were given to selected students as compensation for their participation. To date, 24 students completed the screening survey, and 8 students, all with mechanical engineering backgrounds participated in the study. These 8 students were divided into two teams, Team 1 was a pre-existing senior design team (n=5), and Team 2 was formed by the researchers and thus had no prior experience working together (n=3). Participants were asked to complete a 75-minute focus group session followed by a 1-hour individual interview. This WIP solely presents preliminary results from Team 2's focus group, which consisted of a 30-minute design scenario followed by 30-minutes of follow-up group questions and discussions.

### C. Data Collection

Students were presented with a playground design scenario adapted from other studies [16], [17]. The scenario is both approachable enough for participants to complete under the required time and does not require external engineering resources (e.g., software or hardware tools). Additionally, the scenario was modified to be contextually familiar enough for students to draw from and incorporate their experiential knowledge of the southeastern United States and other geographically similar locations.

“A recent natural disaster swept through a small city on Florida’s gulf coast causing immense property damage. Much of the public property of the city has been destroyed, including the local park. The city has allocated a large repair budget to go into fixing all the problems caused by this natural disaster. Two of the city’s representatives are considering hiring your design team to renovate the city’s treasured park. The park is in a suburban area with no other parks nearby. Work with your team to consider a new design for the park. At the end of your team meeting, you will present your design at the city council meeting.”

During the focus group session, the students were introduced to the design scenario and were instructed that they could request additional design-task-related information from the “city representatives.” Students worked collaboratively over video for 30 minutes with the aid of blank Google Slides to assist in their design development and collaboration. Once students finished the design task, they were given 5 minutes to present their design and were asked follow-up questions related to their design considerations and approach for the remaining 25 minutes. This WIP focuses solely on the analysis of the focus group interview of one of the teams which consisted of three mechanical engineering students that had not worked together previously.

#### *D. Data Analysis*

A qualitative, participant-centered analysis was conducted to explore how students’ backgrounds and experiences may have influenced their design approach. Specifically, the research team used a combination of thematic and constructed narrative analysis [18] to analyze each participant’s considerations and contributions to the design. During the first stage of analysis the data from the focus group transcripts was broken into smaller segments emphasizing moments where participants’ considerations were community-driven. These segments captured moments when participants referred to considerations that related to 1) *self* - something explicitly personal about themselves (i.e., values, perspectives, individual experiences), 2) *culture* - family, culture, or linguistics, and or 3) *community* - the community and local environment. Within these segments, individual statements were then coded as self, culture, or community. This iterative process allowed for themes related to community capital to emerge from the data and for the development of a codebook that could be used in the remainder of the study. The second stage of analysis was to explore the responses of each individual student. All codes that corresponded to said participant were then grouped on a separate document to craft a participant-specific narrative and to examine emergent themes and characteristics pertaining to their considerations. This process was iterated various times by two of the research team members and later discussed until a narrative describing the perspective and approach of each student was formulated. The notes taken during the focus group session as well as the focus group audio were available to help capture any additional information. The narratives were reviewed by the co-authors as a form of critical peer debriefing.

## IV. RESULTS

This section presents the preliminary findings of one of the two focus group interviews conducted. This group included three mechanical engineering students in their first semester of a year-long capstone course sequence. This WIP focused on analyzing the results using the community subset lens of the CCW framework. The results are presented as three narratives focusing on how each participant approached the design problem and incorporated aspects of the community capital. To protect the identities of the participants, the narratives are reported using pseudonyms (JoJo, Rudy T., Tony M.) chosen by the participants.

### *JoJo*

“Oh, well, it’s [the performing arts] something I’ve always been fond of. I’ve done it many times throughout my life. Trying to be the presenter, the comedian, as I’m sure you gathered, I don’t know if I made it clear enough. But yeah, it’s just something that I find myself comfortable doing.”

The presenter and the comedian, JoJo designed to appease. He incorporated several design considerations to ensure that both the local government and the public would be content with the park. Particularly, he wanted to minimize the costs and spending of the park so that the city council would be more likely to approve. For the public, JoJo mentioned several items (e.g., exercise facilities, nature areas, and sports fields) to improve convenience.

Originating from Puerto Rico, JoJo incorporated several parts of his cultural identity in his design process. Particularly, he incorporated his interests of food with the idea of bringing food stands to the park. These food stands would allow people to connect and share their cultural customs through their dishes. JoJo brought himself into design as he mentioned Puerto Rican foods such as “hot dogs, alcapurria, or bacalaitos” as potential stand foods. When asked why food stands, JoJo responded: “I first thought of food in terms of sources of revenue. Like immediately, you know, I like to eat. Other people like to eat, might as well sell food.” By incorporating food stands, he not only incorporated his own identity to the design process purposefully leveraged it as additional revenue for the park.

The group also discussed incorporating the natural wildlife of Florida to the parks’ design. Initially, JoJo expressed his concerns connecting to this area due to not being from Florida, but affirmation from the group enabled him to connect his experiences from Puerto Rico into the design. In thinking about his experiences, JoJo incorporated geographically unique challenges he’s experienced with Puerto Rican wildlife to identify distinctive issues (potential invasive species, pests) and respective solutions (repellent system) throughout the design. This is a demonstration of how community capital can influence a designer’s approach to identifying and solving issues.

### *Rudy T.*

“Yeah, at least to me, I think it’s [the people] more important. Ultimately, the government is the one that makes the final decision, right? But ultimately in the way that we design it, we have to take into considerations how the people around those areas are going to use the park, like if

they're even going to use it or not. What if we just waste all this money making like state-of-the-art things where nobody uses it."

Consistently taking a human-centered perspective within their design approach, Rudy's considerations were primarily driven by two components: the people and their environment. Rudy is a bilingual, first-generation, international student from South America. He has been living in Florida for most of his life and used his knowledge of the area to not only justify design considerations but also to help include others within the team that were not familiar with the area.

Rudy began the design task with disaster prevention in mind. Florida has a hurricane season lasting up to six months every year. Drawing from his previous experiences with natural disasters (e.g., floating debris, knocked down trees), Rudy suggested incorporating preventative measures such as foliage, drainage, and hurricane-proof facilities. In addition, Rudy paired the focus on disaster prevention with a focus on the natural environment. "So, our purpose is to take into consideration the natural environment in [Florida]". Often known as the swampland, Florida experiences heat and humidity year-round. Rudy's approach to selecting elements of the park assured each component matched Florida's natural landscape (e.g., aesthetic fencing, palm trees, mangroves, shade, drainage). In doing so, Rudy demonstrated community capital through his deep-rooted connection and consciousness of the environmental culture within the Florida community.

Beyond his environmental consciousness, Rudy's design considerations were predominantly empathetic and responsive to the cultural systems and challenges within the area. "Yeah, and I feel like it [sports facilities] would benefit the community a lot because you'll have kids that are going to be playing sports, and they'll be going in the parks". Rudy's considerations throughout this design task were innately perceptive of the community's needs and culture playing a critical role in bringing empathy and rationale behind to the park design.

*Tony M.*

"You have to take into account when you're designing not only the actual structure but some things that are needed for operation, and that background of having someone who worked in the operation helped me."

Tony M., an international and transfer student from Latin America, drew upon his previous background and experiences to inform his design approach. His brother, who previously worked at a park, served as a primary source. This gave Tony insight into several administrative factors involved with running and maintaining a park such as storage, clean-up, and outsourcing of services. Tony considered several essentials such as restrooms, water fountains, power, and parking. He also made sure that vending machines and park equipment could be properly stored and secured, as well as ensuring that the park administrative building was hurricane-proof.

"Given the nature of a park, you immediately think of the people who are going to use it." For most of his design approach, Tony's key stakeholders seemed to be both those who would be attending the park as well as those who would be working at the park. He suggested fencing to provide safety for the kids and

green space for those visiting. Particularly, Tony wanted to remove some of the traditional 'cityscape' styles that many cities in Florida have to create a space that people could use with a "natural aspect." Tony also spent a considerable amount of time minimizing costs and ensuring that the park could develop revenue to appeal to the park officials.

Another characteristic of Tony's approach was his decision to create a "layout" of the park one-third of the way into the design. "I am a visual person... that's the way I see design in my head, like something you can lay out and present." Once this was suggested there was a notable difference in how Tony began to immerse himself further into the design process. The way he communicated with the rest of his team and became seemingly more motivated and engaged in the design task once he began creating a layout demonstrates a unique form of linguistic capital. Moreover, Tony is tapping into cultural norms often found within engineering curricula: modeling and sketching to present and further optimize one's ideas.

## V. CONCLUSION AND FUTURE WORK

This WIP aimed to explore how students integrate their community capital into design. The analysis demonstrated that students actively exhibit community capital by drawing from their personal and cultural experiences to inform and validate their design decisions. Moreover, while students shared common considerations (e.g., regard for the environment, seeking revenue sources, people/government as key stakeholders) and cultural knowledge, the perspective and motivation behind their individual design choices were unique to their values and experiences.

This WIP focuses solely on the focus group of one of two pilot studies currently conducted. While the focus group allowed us to make initial connections between students' design choices and their experiences, future work will explore the individual interviews and will aid in further investigating 1) the extent to which students incorporated community capital and 2) to what extent students intentionally draw from these sources. Future work will include analyzing the second focus group which included an previously formed capstone design team. These analyses will allow us to develop a more comprehensive understanding of how students incorporate community capital as well as other forms of capital into their design approach. This work contributes to the field by focusing on understanding students' design process. More so, further implications include helping inform the development of more inclusive and culturally responsive learning environments that enable students to effectively leverage their backgrounds as reliable sources of knowledge and strengths in their design experiences.

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