Using Community Cultural Wealth to Understand Experiences in Physics Bridge Programs

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Many conceptual and theoretical frameworks in education research tend to value social and cultural capital from the most privileged groups and focus on what people from marginalized groups are “lacking.” This kind of research often employs a deficit model of understanding the experiences of people marginalized in education. To fully understand the academic experiences of students from marginalized groups it is crucial to focus on the capital these groups use to overcome challenges. The Community Cultural Wealth (CCW) framework values resources Communities of Color have to help them through various systems such as education. The goal of this project is to understand which forms of CCW students utilize when deciding to pursue graduate education in physics and when they face challenges while in graduate school. To do so, we conducted semi-structured interviews with participants in physics bridge programs from 4 different institutions, and used qualitative coding to identify examples of each of the 6 types of CCW at three different time frames: pre-college, deciding to pursue graduate school, and during graduate school. Our analysis of the data showed that students used familial and aspirational capital during their pre-college experience and navigational and social capital when deciding to apply for graduate programs. Students tended to utilize familial, social, and navigational capital once in their program. We also highlight the impact of family and socioeconomic and ethnic background on experience of students in the APS Bridge Program.
I. INTRODUCTION

Recent physics education research studies reveal a number of challenges that physics graduate students face. For example, Barthelemy, McCormick, and Henderson (2016) [1] documented graduate student experiences of sexism and gendered microaggressions and suggested training and policies to combat the gendered experiences faced by graduate students in physics and astronomy. In their investigation of physics identity development, Hyater-Adams, et al., (2019) [2] found that Black physicists have racialized experiences in physics that influence identity development and experience within the field. They suggest that we interrogate material resources, such as bridge programs, to understand if/how these programs provide students with positive recognition that can influence their physics identity development. Additionally, Sachmpazidi and Henderson (2021) [3] found that in general, physics graduate students experience limited social and academic integration. Through the American Physical Society Bridge Program (APSBP) however, they found that departments can create structures that support student social and academic integration. We cite these three studies as examples of the work being done in physics education research to identify and understand the challenges that physics graduate students face and also provide solutions for facing such challenges. In this study we aim to contribute to this growing body of work by understanding the resources that graduate physics students in physics bridge programs use to overcome the challenges they face in graduate school and as part of their decision to pursue a doctoral education in physics.

Physics education researchers have advocated for research that factors in the demographics of the participants [4] and that utilizes appropriate framing when studying marginalized populations in physics [5]. Thus, we developed our conceptual framework on Community Cultural Wealth (CCW), which utilizes Critical Race Theory to challenge "traditional interpretations of cultural capital" (Yosso, 2005). More specifically, we focus on the experiences of graduate students from minoritized and marginalized ethnic/racial groups using a framework that values the resources that these students bring to academic environments.

A. The American Physical Society Bridge Program

This study focuses on participants of the American Physical Society Bridge Program. The APSBP is designed to increase the amount of physics PhDs awarded to Black, Latinx, and Indigenous students by providing structured support and resources for one’s transition into graduate school. The APSBP collects applications from candidates after the typical mid-April cut-off and sends them to participating institutions, allowing the institution to select candidates that best fit their particular program. Once admitted into the program, the APSBP provides students close support by boosting social integration and mentoring of incoming students. Sachmpazidi and Henderson (2021) found that the support structures in the APSBP are stronger than support structures in programs not affiliated with the APSBP. They provide examples such as strong orientation programs, and specific tutoring sessions for APSBP students [3]. Hodapp and Woodle (2017) indicate that APS helps their incoming students transition by creating programs that promote a sense of community and reducing the economic burden by providing financial support. APS also regularly monitors the progress of affiliated students, especially during their first year, and encourages bridging sites to establish regular staff mentoring [6]. Lastly, compared to the national student retention rate of 59%, the APSBP has a higher retention rate of 92% for their physics students [6].

B. Conceptual Framework: Community Cultural Wealth

Many studies in education research utilize frameworks that value cultural capital from the most privileged groups, which limits the discussion of the experiences of people from marginalized and minoritized groups. To intentionally oppose this practice, we utilize a conceptual framework that is guided by CCW [7]. CCW, which is rooted in Critical Race Theory, calls into question the white-middle-class standard and importantly highlights the valuable resources Communities of Color have to help them survive and adapt in existing institutions such as education. Furthermore, CCW works to prove that these communities do have the necessary skills to be successful, but institutions, such as education, do not appropriately value them. Thus, CCW is largely focused on shifting the idea from "fixing the students" to "fixing the institutions" [8].

Yosso breaks down CCW into 6 different categories that build upon Pierre Bourdieu’s idea of cultural capital. The six forms of cultural capital are: Aspirational Capital, Linguistic Capital, Navigational Capital, Social Capital, Familial Capital, and Resistant Capital. While each of the six categories has its particular definition, they all work hand in hand with one another, as seen in other studies that use this framework [7][8].

- Aspirational Capital: The ability to have hopes and dreams about one’s future, even in the face of barriers.
- Linguistic Capital: The skills attained through communication in different languages or styles. It relates most often to translating, storytelling skills, and communication through art and music.
- Navigational Capital: The skills and abilities an individual uses to maneuver through an institution. It is heavily influenced by social connections.
- Social Capital: The networks or groups an individual can establish. In education, these relationships are student-to-student or student-to-faculty support. These connections give students both emotional and navigational support.
- Familial Capital: The connections made through an individual’s family, community, or kinship. Examples in-
clude direct family, sports teams, or religious groups.

- Resistant Capital: The knowledge acquired through oppositional behavior or behavior that challenges authority.

To be clear "culture refers to behaviors and values that are learned, shared, and exhibited by a group of people" [7]. Cultural capital as expressed by Bourdieu [9] and referenced by Yosso refers to "an accumulation of cultural knowledge, skills, and abilities possessed and inherited by privileged groups in society." The idea of cultural wealth acknowledges that there are multiple forms of capital that are learned and shared within marginalized communities that students use in educational settings.

II. RESEARCH DESIGN

The goal of this study was to determine which forms of CCW participants affiliated with the APSBP utilize in educational experiences and how the forms of capital used vary for different educational experiences. The goal of the interview protocol was to encourage participants to engage in storytelling about their experiences in the APSBP, including difficulties faced within their education and how they worked to overcome them. With these experiences, we could understand how participants in the APSBP utilized specific capital and how that changed.

A. Data Collection

Students who participated in the APSBP for at least one year at one of the original five APSBP sites were eligible to participate in this study. To find participants, we asked APS for contact information for students involved in the program. To date, eight semi-structured interviews have been conducted with participants that self-identified as Black, African American, Hispanic, Latino, Chicano, and Xicano Rican born in Texas. Additionally, these eight participants also self-identified as female, male/man, and non-binary. The interview protocol consisted of eight questions/prompts and follow up questions that were based on the interviewees responses.

1. Tell me how you became interested in physics.
2. Tell me about your decision to go to graduate school in physics.
3. Tell me about your decision to apply to the APS Bridge Program.
4. What kinds of challenges have you faced during your time in your graduate program?
5. What things have helped you overcome those challenges?
6. Have you made or helped to make any changes in your department?
7. How much control have you had in your graduate experience?
8. If you were to face a threat or barrier to your success in graduate school what are the things you would do to address that threat or barrier?

We wanted to encourage the interviewees to honestly share their experiences. Thus, we did not gear our questions toward any specific form of capital.

Analysis of the interviews began with the creation of interview transcripts. Tempkin and Cochran then coded the first three interviews using a yes/no for whether or not a particular code was present. A total of 18 codes were possible based on the six forms of capital included in CCW and three different time frames: pre-college experience, when deciding to participate in the bridge program or graduate school, and during graduate school. The coders initially intended to have separate categories for the decision to go to graduate school and the decision to apply to the APSBP. However, after reading the transcripts and prior to coding, the coders recognized that most participants discussed making the decision to go to graduate school and the decision to apply to the APSBP simultaneously. Thus, these were combined to be one time frame. This resulted in the 18 possible codes seen in Table 1. After comparing a spreadsheet of codes for each of the interviews, Cochran and Tempkin discussed any differences in coding. In interview 1, there was 100% agreement for all 18 possible codes. In interview 2, there was 88.9% agreement, and in interview 3 there was 67% agreement. Based on this first discussion, Tempkin and Cochran re-coded the first four interviews. The overall inter-rater agreement post discussion was 100%.

Inter-rater agreement is one method for researchers to confirm that they are conducting analysis in the way they intend. We found that calculating inter-rater agreement - the degree to which our codes were identical given that the option was either yes/no for the 18 codes - was more beneficial than inter-rater reliability, which measures the extent of variability within a measure [10]. The method we chose to determine inter-rater agreement was a percentage based on the number of codes on which we agreed (as yes or no) for each transcript and the number of codes for which we could have agreed, 18 in all cases. The choice for determining inter-rater agreement is often a personal choice based on the research design [10]. In our case, it was helpful to determine inter-rater agreement as Cochran was initially more likely to only code an experience as illustrating one form of capital. Post discussion, Cochran was more careful to check for all forms of capital in the experiences shared during the interviews as sometimes a particular experience illustrated more than one form of capital. This change in Cochran’s method of coding resulted in the higher level of inter-rater agreement among the coders.
### III. RESULTS

Our study showed that participants within the APSBP utilize all six forms of capital during their educational experiences. Table 2 includes selected excerpts from the interview transcripts to illustrate the various forms of capital. One trend seen in the data was that the majority of pre-college codes were familial and aspirational capital. There were no pre-college experiences coded as resistant or linguistic capital. Secondly, most participants utilized navigational and social capital during the decision/application process of graduate school and/or the APSBP. Lastly, for all interviews familial, social, and navigational capital were illustrated in relation to experiences during graduate school.

#### A. Additional Findings: Familial Capital

When conducting qualitative research it is important to listen to the data. This requires noting what is there even if it does not directly address your research question. From listening to the data, we found that familial capital was a vital form of capital utilized by the participants throughout their experiences. Several pre-college experiences were coded as illustrating familial capital and all of the transcripts included experiences during graduate school where familial capital was utilized. The authors noted that during the interviews, there was a clear change in the physiological state of the participants as they discussed the role of family and the impact of graduate school on their connection with family. One participant, who used the pseudonym Amaru, said

I’m the oldest of my siblings. My mom needs the help, and it was always hard to not be around. At the time I left for grad school, my little brother was just born. So he was a baby, and he grew up without me. He grew up without my accent, without my way of being, and so it always felt like I was missing out on the development of my family. ...

Also being away from my family, my great grandma passed away, and she was the last person of her generation. Like, that was my last great grandparent alive and at this point I was trying to figure out my roots and figure out where I come from because I had to learn about myself, and I never got a chance to ask her about her grandparents ... So like if this was the movie Coco, like that generation is now gone you know what I’m saying. So not having the opportunity to be around my family to ask those questions of where I come from, it’s a lot of information and a lot of knowledge that grad school would never, never ever provide for me.
Multiple participants discussed the impact of being away from family. During Amaru’s interview, Amaru mentioned that other students in the APSBP were also struggling with this issue and that they were trying to bring people together who faced a similar challenge. Amaru discussed efforts to "bring together other people who left their families behind, to pursue a graduate education."

B. Additional Findings: Socioeconomic and Ethnic Background

In our analysis, we noticed that socioeconomic background was a notable marker of difference [11]. We did not specifically ask participants about their socioeconomic background, but socioeconomic backgrounds among participants clearly varied. For example, one participant mentioned that her mother was a medical doctor, while another participant mentioned that their family members were migrant farm workers. So, we cautiously assume that the socioeconomic backgrounds of these two participants are different.

Differences in ethnic background and socioeconomic background caused some participants to be isolated - even within the bridge program. For example, one participant, who used the pseudonym Jorge, said

Here, it's like I'm not connected with people. ...it's very difficult for me to even interact with other people. ...I do not connect with other graduate students, including graduate students who are from other minority groups and are in the bridge program. I just don't have much in common [with them]. Yeah, I think that has been the most difficult. Not the classes, not the research, it's just interacting with graduate students including the ones from the bridge program.

For other participants, sharing a similar socioeconomic background helped them to connect even when they came from different ethnic backgrounds. One participant contrasts the connection between bridge program participants with other graduate students. He said,

All of us are either People of Color or Black, and often we're ...first people in our family to go to college and to have any type of degree. A lot of us ...we come from poor economic backgrounds, and maybe not all of our parents - thankfully mine do! But maybe not all of our parents support even us being in a grad program. Things like that, I would say. It's hard to find those commonalities between the other grad students as a whole.

IV. DISCUSSION

This ongoing project has yielded important preliminary findings. We found that all six forms of cultural capital were evident in the experiences shared by the study participants. CCW is a powerful way of acknowledging and understanding the various resources that students from minoritized ethnic/racial groups bring to their educational experiences.

Given that this is a qualitative study it is appropriate to explicitly state the trends that we found so that the reader can determine the transferability of results to other populations and contexts [12]. We found that pre-college experiences included a lot of aspirational and familial capital. This seemed reasonable as many students develop interest in science careers early in their educational journey due to family encouragement. We found participants utilized navigational and social capital most when deciding to go to graduate school. This may be because the decision-making process involves figuring out how and when to apply, and how graduate school might be financed [13]. Finally, participants used multiple forms of capital when faced with challenges in graduate school. These experiences presented unique challenges for participants, requiring them to incorporate all of their resources to overcome those challenges.

Additional findings included the importance of familial capital in overcoming challenges during graduate school and also the impact that the graduate school had on familial relationships. This finding led us to more questions. What are the implications of "leaving family behind to pursue graduate education?" What can be done to mitigate the negative impact of this process? What changes in policies and practices in education might eliminate this problem?

Prior to submission of this paper, Cochran presented these findings to bridge program students at one of the APSBP. They confirmed that these findings resonated with their experiences. Future work will include continuing the member checking process by sharing an expanded version of our findings with participants and soliciting feedback via written form and interviews.

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