

Understanding familial capital and its implications for physics graduate programs

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In recent years, multiple physics education research studies were conducted with a goal of understanding and improving graduate education in physics. Using a variety of frameworks and methodologies, these studies have documented policies and practices in graduate programs and the results of these studies have influenced policies and practices within graduate physics programs. Through this paper, we seek to contribute to this growing body of literature by uplifting the experiences of graduate students who have participated in bridge programs and identifying the implications of our findings on the policies and practices of departments aimed at improving graduate students experiences. Drawing on data from a larger study aimed at understanding culture within departments with bridge programs and utilizing the community cultural wealth framework, we elucidate the concept of familial capital and offer suggestions for how physics graduate programs might alter policies and practices to better leverage this particular form of capital.

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I. INTRODUCTION

Like many physicists from other subdisciplines, physics education researchers investigate research questions that are interesting to them because they are curious. However, many people in physics education research (PER), especially those who conduct equity-oriented PER, are also motivated to conduct research that has the power to impact policy and practice. Through the work of the Inclusive Graduate Programs in Physics project [1], a subset of the authors on this paper found that physics faculty attribute changes to the practices and policies within their department to the findings from PER studies. Particularly, when asked about changes to the graduate admissions process, several faculty members indicated two physics education research articles [2,3] had been brought to their department's attention, with some indicating that these articles were discussed during faculty meetings. As another example, when concerned about the inequitable traditional practices in physics graduate admissions, physics faculty at Michigan State University (MSU) engaged in scholarship in graduate education. They then decided to invite two members of the

Inclusive Graduate Education Network (IGEN) to lead a workshop for faculty serving on the graduate recruiting committee. As a result of that workshop, MSU now uses holistic admissions processes [4]. Motivated by such anecdotes, this paper aims to contribute to the growing body of work in graduate education that has—or has the potential to—impact practice and policy in graduate programs.

In this study, we use familial capital—one form of capital included in community cultural wealth—to center the experiences of graduate students who have participated in physics bridge programs. When used as framework, community cultural wealth allows researchers to identify the resources and skills that these students use in overcoming challenges in their educational experiences. Particular attention is paid to the role of familial capital, the knowledge, learning, and practices that are passed down through kinship and community, in navigating the graduate experience as it has been found to be a significant part of how students in physics navigate challenges during graduate education [5]. These results can inform policies and practices within physics graduate programs to create inclusive learning environments that allow graduate students to bring their full selves into the educational environment. As an introduction to this study, we review the literature on graduate education in physics, bridge programs, and community cultural wealth.

A. Graduate education in physics

The culture in physics (and science more broadly) is characterized as being competitive and individualistic,

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traits that are stereotypical characteristics of white, male scientists from high socioeconomic backgrounds. Those who do not share these characteristics in such environments are often marginalized [6,7]. The notion of meritocracy dominates the structures and policies in science and grants access to those who are socially privileged. Research in higher education consistently demonstrated that students from traditionally underserved populations leave science fields due to the discriminatory structures and cultures [8]. As a result, meritocracy does not help democratize spaces as intended initially but rather discriminates against those who have historically been excluded from educational, political, and economic participation. The goal of equity-oriented research on physics graduate education is to surface and alter this discriminatory, racist, and sexist culture [9]. This is especially salient work because some physicists describe the physics culture as cultureless, objective, and apolitical [10,11]. The widely held notion of “objectivity” in physics culture creates negative implications that hinder the advancement of equity goals [12].

PER scholars aim to identify ineffective patterns and practices in physics education and study and propose alternative approaches that result in a more productive educational experience for students. Graduate education in physics is a growing area of focus among PER. The literature in graduate education has primarily been approached through an equity lens, focusing on the systemic and cultural barriers to equitable access and participation [2,4,13–20]. For example, a significant body of PER literature focused on equitable physics graduate admissions such as using holistic admission practices, rubrics, and dropping the use of standardized test scores [2,4,13–18,21,22]. PER scholars also focused on the experience of those impacted by this culture, documenting microaggressions and isolation in physics programs [12,20,23–25], and proposing a number of policy recommendations for more inclusive and equitable graduate education spaces [20,24]. A combination of this type of work across multiple science disciplines helps shape change initiatives that aim to support department members in altering their program cultures (e.g., Inclusive Graduate Education Network [26]).

B. Physics bridge programs

A significantly higher proportion of White and Asian American undergraduate students attend doctoral programs than Black and Latinx students [27,28]. Researchers have indicated that one reason for the disparity is that Black and Latinx students are more likely than White and Asian American students to be the first in their families to attend college [28,29]. Bridge-to-the-Doctorate programs were created across science disciplines to eliminate the disparity between marginalized students’ participation in undergraduate and doctoral levels [8,30] by establishing a structure to ensure that students in bridge programs attend

departments with supportive environments conducive to student success [30]. Supportive systems such as bridge programs are meant to solve easily fixed problems that, due to class distinctions, manifest differently based on socio-cultural backgrounds.

Bridge programs were designed based on the assumption that, for reasons such as the Graduate Record Examination or lack of undergraduate research experience, among others, capable and driven students either do not consider pursuing doctoral degrees [19] or are not fully prepared to succeed without the necessary support structure. To address this challenge, bridge programs were designed to support students toward a smooth transition into Ph.D. programs [30].

The first bridge program was a partnership between Fisk University—a Historically Black University—and Vanderbilt University, a Predominately White Institution (PWI). The partnership is known as the Fisk-Vanderbilt Master’s-to-Ph.D. Program founded in 2004 [28]. Undergraduate Fisk students receive mentorship, academic training, and research experiences through the bridge program, and these supports continue when students transition into their Ph.D. program at Vanderbilt [31]. The second bridge program is the Columbia Bridge-to-the-Ph.D. Program founded in 2008. Since then, several others were developed, such as the American Physical Society’s (APS) Master’s-to-Ph.D. Bridge Program founded in 2013 with six sites and several partnership and affiliated programs [28,30], and the Cal-Bridge CSU-University of California Ph.D. Bridge Program in 2014 [32].

The APS bridge program focuses on recruiting students and placing them at a number of physics programs across the country. The APS bridge program was developed based on three critical components, including (i) recruitment, dissemination, and tracking applications from students who did not get admitted, (ii) establishing bridge sites in selected physics programs that will enable students to make a smooth transition to a graduate program and be well prepared academically, and (iii) conducting research in physics graduate education [30]. In the following paragraphs, we expound upon the two latter components, establishing bridge sites and conducting research in physics graduate education.

The APS bridge structure was designed to help prepare students academically before transitioning into the graduate program [30]. Once the student in the APS bridge program is formally enrolled in the Ph.D. program, they receive financial support before their arrival on campus to assist them with the relocation expenses. Moreover, the bridge program ensures a smoother academic adjustment tailored to student needs. The students in the bridge program are invited to take a diagnostic test. The results of the diagnostic test are often used by academic advisors to design a personalized coursework plan. In parallel, through the peer mentoring program, the student gets a smooth social adjustment. Peer mentors are only one of the mentoring sources encouraged by the bridge program.

APS encourages a constellation model of mentoring which requires that students can access different perspectives and supports (e.g., staff, instructors, and faculty) [33]. Finally, the program begins monitoring students' progress as early as the second week of the graduate program. Progress monitoring is a critical component of the Bridge Program, as it enables timely intervention and increases the likelihood that students receive the support they need.

Since the inception of the first bridge program, several promising outcomes have been reported. For example, by 2019, of the 146 students participating in the Fisk-Vanderbilt Program, over 95 earned master's degrees and 33 Ph.D.s. Nearly 89% of students in bridge programs complete their Ph.D. within 8 years [28,31]. A 2013 *Physics Today* article reported a 92% retention rate for graduate students in bridge programs (MS and Ph.D. degree-seeking), defined as the proportion who remain in and progress through their graduate programs rather than dropping out [30]. This is significantly higher than the national physics graduate student retention rate of 59% [34].

The positive retention and graduation outcomes for students in bridge programs are only one sided. Research on the challenges students in bridge programs face while attending PWI graduate programs indicates that these students experience othering from nonparticipating peers in the form of resentment and microaggressions [35]. Moreover, faculty hesitate to work with students in bridge programs, expressing it as "risk-taking," citing students' lack of undergraduate research and academic experience. These negative experiences with peers not participating in the bridge program and faculty contributed to experiencing the department as hostile and unwelcoming [20,35].

The "bridge student" became a label to scrutinize students further, presenting them as noncompetent or worthy of being in graduate programs, thus perpetuating the systemic failures toward equity and inclusion. In contrast, it is important to continue providing the support to marginalized students that due to systemic inequities were previously denied access to graduate programs by changing the underlying systems and cultures within PWIs. At the same time, it is critical to expand the definitions of success or talent that have historically only been tied to social and cultural capital from socially privileged groups.

In this paper, building on the existing scholarship on physics graduate education and bridge programs in particular, we unpack an understudied aspect of physics graduate students from marginalized backgrounds, community cultural wealth [5]. In doing so, we focus on the account of students in bridge programs and propose a set of actionable ideas around ways to embrace the unique experiences and backgrounds that students bring into their departments.

C. Community cultural wealth vs cultural capital

Cultural capital is a concept that originates from the work of sociologist Pierre Bourdieu and refers to the

noneconomic assets that an individual possesses, which contribute to their mobility and status within a social structure [36]. These assets include knowledge, skills, values, and behaviors that are valued by and can be used to navigate particular social contexts. Students with high levels of cultural capital often find it easier to navigate academic environments because they are familiar with the expectations, behaviors, and norms of academic institutions, such as knowing how to communicate with professors, seek help, access resources, and understand the "hidden curriculum." However, the application of cultural capital as a framework for examining the experiences of students from historically excluded groups can create a deficit mindset where students from marginalized or non-dominant cultural backgrounds may be seen as lacking cultural capital because their knowledge, skills, and experiences do not align with those valued in academia. This can lead to other cultural assets being undervalued or ignored.

In contrast to cultural capital, community cultural wealth (CCW), proposed by Yosso [37], is a framework that acknowledges the diverse forms of knowledge, skills, and resources that students from marginalized communities possess. This includes traditional and nontraditional notions of cultural capital such as social, navigational, linguistic, familial, resistant, and aspirational capital. Unlike cultural capital, which tends to prioritize and validate dominant cultural norms, CCW recognizes the strengths and assets inherent within marginalized communities, challenging deficit narratives that portray these communities as lacking [38–40]. CCW offers a more inclusive and empowering perspective. By recognizing the diverse forms of knowledge and resources that students bring from their communities, educators can validate and leverage these assets to support academic success. For example, linguistic capital—the ability to communicate effectively in multiple languages—can be viewed as a valuable asset, facilitating cross-cultural understanding and enriching classroom discussions rather than being viewed as a language barrier. Similarly, familial and community support networks can provide students with emotional and material resources that contribute to their resilience and academic achievement.

However, despite its strengths, the concept of CCW is not immune to critique. In some contexts, there is a risk of essentializing and romanticizing marginalized communities, reducing them to monolithic entities with fixed cultural traits. This can perpetuate stereotypes and overlook the internal diversity and complexity within these communities. Additionally, the emphasis on CCW should not overshadow the importance of addressing systemic inequalities and providing equitable access to resources and opportunities for all students.

While cultural capital and CCW both pertain to cultural resources, they differ fundamentally in their origins, implications, and approaches within academia. Cultural capital

often reinforces existing power dynamics and inequalities, while CCW offers a more inclusive and asset-based perspective.

D. Cultural capital and community cultural wealth in PER

There are a few examples of traditional notions of cultural capital, or social capital in particular, being used as framework in PER. More often, the framework is used to explain the results of a study rather than used as a framework that guides the design and methodology [41–44]. For example, Lung *et al.* found that “interest between college generations is consistent with a social capital conceptual framework, which points to the comparatively lower level of initial social capital first generation college students possess” [42] (p. 4). This work references the social capital framework again stating that this framework “might also explain the relatively strong interest of first college generation students in engineering by suggesting that engineering is a more tangible and accessible career option than physical science to those unfamiliar with the academic world” (Lung *et al.* [41], p. 4).

Similarly, forms of cultural capital included in the CCW framework are also referenced in PER studies [45–47], with only a few using it as a framework [5,48]. In this paper, we draw on data from a study [5] conducted by a subset of the authors that used CCW as framework to illustrate familial capital and identify ways that it can be positively leveraged to impact policy and practice in physics graduate programs.

II. METHOD

This study is a secondary analysis of data initially collected as part of a study identifying the community cultural wealth participants affiliated with the APS Bridge Program utilize in education and how the forms of capital used vary for different educational experiences [5]. While the initial study included all six forms of capital included in Yosso’s [37] framework, in this study, our analysis focuses solely on familial capital. The initial analysis was performed by authors Cochran and Tempkin [5], the secondary analysis presented in this paper was performed by authors Cochran, Henige, and Nelson.

A. Participant recruitment and selection

All participants in the study were students in one of the six original bridge programs funded by the APS [30]. While there are several bridge programs at various institutions, some of which are member or partner institutions of the APS Bridge Program, there were only six bridge programs originally funded by the APS. Our participants were enrolled in a bridge program at one of these institutions for at least one year to be eligible to participate in the study. We received no eligible candidates from one institution and no responses from potential participants at another institution. We later found out that the bridge program at one of the institutions

was dissolved and it is not clear if the bridge program at the other institution was active during the time of our data collection—which may be why we did not receive responses from any students at those two institutions.

We obtained a list of student participants in the APS-funded bridge programs from APS staff. We emailed each of these students inviting them to participate in an interview. All students who expressed interest and responded to schedule an interview were interviewed. These students comprised the original eight participants. Through our continuous member-checking process, five additional participants were enrolled in the study—with Institutional Review Board approval. These five participants also met the requirement of participating in the APS Bridge Program. Member checking for this paper consisted of six participants, two of whom participated in the original interviews and four who became participants in the study at later stages.

In line with an anticategorical intersectional approach [49,50], we did not categorize ethnicity, race, sex, or gender in data collection. To ensure our sample was representative of the participants who participate in the bridge program, we did ask participants how they identified in terms of race/ethnicity and gender/sex. In some cases, participants used more than one term to identify themselves in terms of race/ethnicity and gender/sex. In terms of ethnicity or race, the 12 participants whose data were used in the analysis and member checking for this study identified as Black, African American, Hispanic, Latino, Chicano, or Xicano Rican born in Texas. In terms of sex or gender, participants identified as female, male, man, woman and nonbinary.

B. Data collection

Data were collected via hour-long, virtually conducted, semistructured interviews with participants. The interview protocol consisted of the eight questions or prompts enumerated below.

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?

The semistructured interviews allowed participants to answer preset open-ended questions that guided

participants to explore a variety of topics relating to experiences and obstacles during their educational journeys [51]. The goal of the interview protocol was to encourage participants to engage in storytelling about their educational experiences, including difficulties faced within their graduate programs. Thus, we did not gear our questions toward any specific form of capital. However, in some interviews, follow-up questions included references to specific forms of capital.

C. Data cleaning and analysis

All interviews were conducted via Zoom and thus we used Zoom's captioning feature to provide the initial transcript. Then, a subset of the team—Cochran, Tempkin, Henige, and Nelson—cleaned the transcripts by listening to the audio and correcting any errors made by the Zoom captioning process.

In our secondary analysis of the data, presented in this paper, a subset of the author team, Cochran, Henige, and Nelson, reviewed the transcripts of all eight initial interview participants and identified, via coding, excerpts that highlighted familial capital as described by Yosso [37].

D. Continuous member checking

Member checking often entails returning the data or findings of a study to participants to validate the researchers' interpretation. However, in qualitative research, member checking can serve a number of purposes including validation of data, increasing the trustworthiness of findings, and bringing about change [52]. In preparation of products related to this study, we sought to accomplish all of these. Thus, the member checking for this study was continuous.

After completing the initial analysis of the interview data, which included all forms of capital, Cochran presented the findings to a subset of the initial participants who were available. Based on this feedback, Tempkin *et al.* developed a proceedings paper on the study [5]. During the member checking process for the proceedings paper, participants suggested creating a resource guide to help other graduate students recognize their community cultural wealth. In response, Cochran *et al.* created a resource guide "Identifying and Leveraging Community Cultural Wealth in Physics Bridge Programs" [53]. Based on suggestions from the participants during the member-checking process for the resource guide, this author team sought to focus solely on familial capital in our secondary analysis. Second, the author team was encouraged to develop a product that focused on what departments can do or a product that not only helps faculty and administrators recognize familial capital but also think about what that means for departments. The author team aims to fulfill that request by identifying relevant policies and practices in the implications section.

The six member-checking interviews for the findings and implications of this paper were conducted via Zoom and lasted approximately 30 min. Prior to the interview, the participants were emailed the findings and implications

included in the initial draft of this paper. Two of the participants requested the full draft of the paper and were sent that via email. The transcription and transcript-cleaning process for the member-checking interviews was the same as described for the initial interviews. The protocol for the member-checking interviews included the following:

1. I have some specific questions that I would like to ask, but I want to begin by hearing about your thoughts and impressions on the findings and implications of this paper. Please feel free to share any reflections you have on the pages that were shared with you.
2. Do you think the excerpts that we selected for this paper illustrate the various aspects of familial capital that we drew from Yosso's definition?
3. I would like to go through each of the implications with you. I would like to know if this implication resonated with you and if so, why, and if not, why not. We would also like to know if you would change any of the practices or policies recommended.
4. Are there any implications you think we are missing?
5. What are your thoughts about our first paper focusing on familial capital rather than on other forms of capital? As a reminder, the forms of capital we included in our study are aspirational, linguistic, resistant, navigational, social, and familial.
6. What would you like to see next from this project?

The results of the member-checking interviews are included in the next sections on findings and implications.

III. FINDINGS

In this section, we use our findings to illustrate Yosso's definition of familial capital through the inclusion of excerpts from our interviews. In particular, we chose participants' quotes that we believe elucidate familial capital. We also include excerpts from our member checking interviews that capture participants' responses to the quotes we chose. We have included whether the quote came from the initial interview or from member checking. Participants were encouraged to create a pseudonym for us to use in dissemination. In some cases, the participants provided a pseudonym, in other cases they approved the researchers creating a pseudonym for them. In cases where neither of those options were chosen we acknowledged the participant according to interview number. Because it is important for the conceptual framework to contextualize the findings [54], we include quotes from Yosso's seminal work on CCW in our findings section. The quotes from the participants are italicized and identified. The quotes from Yosso are identified and in plain text.

A. Familia (kin)

"Familial capital refers to those cultural knowledges nurtured among *familia* (kin) that carry a sense of

community history, memory and cultural intuition” (Yosso [37], p. 79). This cultural knowledge is passed from family to graduate students to support them when they face challenges. In describing the support she received during her graduate program, one participant said

... both my parents and especially my grandparents have been very supportive ... I’ve definitely had that sort of support from my family if I’ve ever needed anything, whether it’s struggling in the program and talking to someone about it, or even any other sort of assistance. Like my grandparents came to help me move here and things like that, so I definitely have a solid support system that I’m grateful for at home. (Crystal, initial interview)

Familia, as illustrated in the quote above, includes kin. It is more than just immediate family. It can also be extended family or community members. Indeed, As Yosso states:

Acknowledging the racialized, classed and heterosexualized inferences that comprise traditional understandings of “family,” familial capital is nurtured by our “extended family,” which may include immediate family (living or long passed on) as well as aunts, uncles, grandparents and friends who we might consider part of our familia. (Yosso [37], p. 79)

We include the quote below as an illustration of familia that extends beyond family to individuals who are like kin and provide cultural knowledge. These are individuals to whom one may not be related, but with whom one can deeply relate.

The boss at the previous job that I had ... He comes from a very similar background that I come from, migrant farm worker family ... so I related to him on those wavelengths. He was providing different resources of how to move. Asking me questions about the move like, “Hey have you thought about ... the shampoo ...” I don’t know ... he would just ask me these random questions at the time that I had never really thought about making the move, and it would just get me thinking about, “Hey, oh yeah, I still need to do this, I need to do that.” He really helped me prepare by asking me those questions and making me think about things that I hadn’t thought about before. (Participant 2, initial interview)

For this participant, the cultural knowledge passed to him concerned things to consider before moving to a different region. The person who shared this information

was not a relative, but someone from a similar background to which he could relate.

Participant 2’s quote resonated with multiple individuals who participated in the member-checking process for this study’s findings. When asked if she had “any thoughts or implications about the findings of this paper?” Deja said,

... I thought it was really good. Made some really good points. Especially, you know, kind of expanding that family isn’t just, you know, like your mother and your father, like people directly related to you. And I think it’s really important. So yeah, it was good. (Deja, member checking)

Deja brought this up again when asked “Do you think the excerpts that we chose for the paper illustrated the various aspects of familial capital that we pulled from Yosso’s definition?”

Yeah, I think they were good, especially having that one example where it was a [employer] instead of someone’s actual family was good. (Deja, member checking)

Another participant felt the paper should include more examples that illustrate that family is not just chosen relatives.

... another thing that’s touched on is that, you know, your family isn’t chosen. I mean, ... it’s not just, you know, your pure family. So from what I understood, it could be ... and it even says it, that it’s an extended family or other community members or even friends ... that particular aspect of [Yosso’s] definition ... or the excerpt that kind of talks about that is the person having a previous boss that had a similar background ... they were just kind of like sharing that kind of knowledge. And I think that’s a good example of one ... a broader community member, but I think it also ... it’s like having a friend support group you know ... I think that I would think that would be a part of familial capital or maybe there wasn’t actually an excerpt specifically on that. Because one thing for me that I found in my career here is community support from my friends. Those are my chosen family. (Jimmy, member checking)

B. Cultural knowledge

Participants also illustrated that they are aware of the importance of the cultural knowledge that comes from *familia* and also their role in passing cultural knowledge on to other members of their family. This is illustrated in the excerpt below. Prior to the response shared below, the participant was asked about the kinds of challenges faced during their time in the graduate program.

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. (Amaru, initial interview)

Amaru acknowledges the cultural knowledge that he was not able to receive from his grandmother while he was away at school and also the cultural knowledge that he would not be able to pass on to his little brother as a result of the geographical distance. This experience as illustrated in Amaru's quote resonated with other participants as well.

Just reading through the findings and the excerpts of some students what they had said it's very, you know, I get it ... especially the one, I think it was the participant Amaru ... He and I also have similar experience ..., my grandpa passed while I was in this program. So there's a lot to that. You know, I was able to see him before he, you know, passed. I wish I was able to see him more often ... And at least when ... I felt like, I felt like—don't get me wrong, I was always going to go see him—but, it was also weird that I had to even ask permission ... But, anyway, that particular excerpt really resonated with me. (Jimmy, member checking)

Yeah, it resonated with me personally because over the past few years ... I've had a lot of that experience where I kind of needed ... to help with my family and stuff like that. My aunt, she died like five years ago but her children, my cousins were all in like a very uh like a strenuous place in their life. And they're [in their] formative years so they could easily take the wrong turn and I had to be there for that. But since I was in grad school and I couldn't get away time, it was just kind of hard to ... to operate here and still have to have one foot back at home. (Isaiah, member checking)

C. Focusing on familial capital

During our member checking, we specifically asked participants "What are your thoughts on our first paper focusing on familial capital? So we created a resource guide that focused on all the forms of capital that were in Yosso's original community cultural wealth framework, but our first paper is just on familial capital." Many of the participants' felt that doing an analysis that focused on familial capital and aiming to publish those results first was a good idea.

I think it's a good one to focus on because like lots of bridge students who happen to be People of Color like maybe this is an assumption, but like, you know, maybe have like closer familial units. Like I know, like in my culture as an African-American and like a Latino individual, family is a really big thing. And so, I know that a lot of at least from my conversations with my friends, who most of whom happen to be bridge students, we talk about our families a lot. And, you know, not only trials and tribulations, but the ways in which like family matters to us throughout like our Ph.D.s, so I think it's a good one to focus on ... [other forms of capital] are all super important ... But I think those things are often focused on or passed down from bridge student to bridge student ... But I don't know if the familial part was something that was a focus when I got here. (Nasir, member checking)

Another participant said,

I like that. I think ... because that's kind of ... it's highlighting and exposing that we're different. We come from different backgrounds, different cultures. And one way that we kind of highlight that or can highlight that is with this familial capital. Because I can imagine a ton of people would read this and read the experts and they'll be like, "oh, I never thought about that." You know, it's like, ... it's saying it without saying it ... You have different cultures and different communities that have a different relationship with your family. You're multigenerational. I think the nuclear family, that idea's old and that's, you know, that's not the only ... that's not just what family is, right? But I like the idea of focusing on the familial capital. I think it's very powerful because that's something we can all relate to in some shape or form. And the realization that, yeah, it's not just your brother or sister and your parents it goes beyond that and what those strengths and what you can gain from that, that's very, very impactful. (Jimmy, member checking)

One participant was concerned about us starting with familial capital as she was worried that it would not

resonate well with readers because it is a difficult topic to grasp. She said

Familial is the hardest one to me. And when I mean hardest—to translate and relate to ... So you can look at it ... like, “yeah let’s just get this one out, you know, because this is going to be the one that’s probably the most questions, you know, people, you know, trying to understand exactly what we’re talking about here and then we can go on to ones that are a little bit more obvious.” I personally would probably start with something that I know would go over well, what people would connect with, they would understand, they would be able to easily say, “okay, ah, I see.” (Erika, member checking)

Another participant felt it was good to start off with because many people could relate to it, but also felt that it was not the most important form of capital. He said

It may be my least favorite ... That resistance capital or that aspirational capital, I think ... plays a very ... I’ll argue just as big of a role as this capital. But again, like familial capital isn’t really my thing. But yeah, no, I mean, I think it’s a good one to start off with, without a doubt, I think a lot of people can relate to it, which is why um, yeah, that I think it is a good one to start off with. (Chris, member checking)

To summarize, in this study, we found instances of familial capital as described by Yosso [37]. We also found that participants acknowledged the importance of familial capital in their lives and the lives of their family members, and the challenges of being geographically distant from their family during graduate school. It is with these findings in mind that we offer the implications in the next section.

IV. IMPLICATIONS FOR PHYSICS GRADUATE PROGRAMS

One aim of equity-oriented research is to impact policy and practice. To be clear, we define equity as “correcting historical or existing injustices to make things more just or fair (Cochran [55], p. 5; [56]). With this in mind, we identified implications for various policies and practices in graduate programs that would improve experiences for students participating in bridge programs and potentially other graduate students, making these programs more just and fair. We generated the first four suggestions based on our understanding of the participants’ experiences and our knowledge of graduate education. The fifth suggestion came directly from a member-checking interview. We have included in this section quotes from the member-checking interviews to further validate our findings and implications.

A. Acknowledge familial capital

Practice: Become familiar with familial capital. As mentioned previously, we chose to focus on familial capital in our secondary analysis because it is something that resonated with many of our participants. Most of the participants who participated in the initial interviews described familial capital in answering our questions about how they overcame challenges in their educational experiences. During the member-checking process, most participants—though not all—felt that it was important for graduate programs to recognize familial capital.

... it’s one of those things where it should be a little bit more obvious, like, “hey, you know, we should be more mindful of how people are more connected with their families.” Because I feel like there’s just, like, a severe lack of that in the department sometimes. We’re like “oh, wow, you actually care about your family” it’s like “yes, I do. I don’t know why that’s so hard to understand.” ... I think [it] is one of those things people don’t realize isn’t happening. But once you say it out loud it’s, like, well, yeah, obviously that’s, like, not a good mindset to have, you know. We should be taking care of the people around the students as well. (Deja, member checking).

I think that focusing on family, like the ways in which like bridge students like need the support of their family or support their families is really important because I find oftentimes there’s not a huge focus on familial capital in a physics program, and I know like other bridge students who have had familial issues that have either caused them to leave or caused them to take a break or cause them lots of stress throughout the program because there wasn’t a lot of accommodation or understanding towards the nature that lots of like underrepresented people have towards their families—like the nature of those relationships. And so I thought it was really nice to have people highlight their own experiences and talk about their own experiences and how they navigate bridge programs with their family in mind. (Nasir, member checking)

B. Allow for away time

Policy: Ensure graduate students have time to travel home to visit family should they choose to do so. In some institutions, vacation time for graduate students is determined at the institutional level. This is often the case, when graduate students are classified as employees or when graduate students have unionized and this is part of their contract. At other institutions, there is no policy regarding time off and the amount of time, if any, that graduate

students have to visit family is dependent on their faculty advisors or those who oversee their lab. This means that even within one department, time to visit family could vary from one research group to the next. We encourage the development and implementation of a department-wide policy on “away time” for graduate students. We are suggesting this time away be in addition to any institutionally mandated vacation time and university closings.

This implication resonated with many participants during the member-checking process.

Yes, I think it definitely resonates, especially, you know, not having any family that’s kind of been through academia. Where they kind of see it as, like, a job where they’re like, “Oh, can’t you just ask for, like, PTO [Paid Time Off]?” or, like, you know they, like, either see it as, “oh, you’re a student and you can just like take time off, whatever you need” or, like, it’s a full-on job where you need to, like, request time and all this other stuff. So not really knowing where you stand between being a student and like, oh, do I need to ask and, like, put in PTO time is kind of confusing, especially, like, when you’re the only one in your family that knows how to deal with that stuff. So having a department policy on it, I think would make it really clear. And like, you know, what your sort of, like, rights are in terms of asking for time off. (Deja, member checking)

Yeah, it definitely resonates. I think that’s very important. I think many of the students, especially coming from more, I guess we like to say marginalized backgrounds, have very strong ties with their family and they need that support. So I think it would be advantageous to allow them to have some time off when they need to. Maybe they’re going through a tough period or maybe they just are getting really homesick and having that little boost of encouragement and motivation from their family would be helpful. (Erika, member checking)

Two member-checking participants expressed concern that allowing for away time might be seen as mandating that this time is used to visit family, which could be problematic for some.

Talking about away time. I think that it would be beneficial because lots of people have familial situations where you know they need to be home for some point in the year to help take care of their family or to help, you know, just like engage with their household, I think. And for me that has kind of been the case, and I haven’t been able to do that because I’m here I guess. Like on the other hand,

I also think that, you know, distance can sometimes be beneficial depending on like your family situation so like I’d say yes with caveats. (Nasir, member checking)

It does resonate with me, but at the same time it does not. I think going home to travel to visit family if you choose to do so, is a tricky situation. There are fears that there are conflicts from being within a family that can bring ... on more stress than it may actually be worth. In addition, for some of us who are coming from situations where it is very dangerous to go back home, right? It may not behoove you to do so. Right? So I think that’s why it doesn’t so much. But at the same time, like, it’ll be good to see my mom ... we definitely should have a policy regarding how much time and everyone should follow a set policy on how much time say a student gets off but um I don’t know. I think for me personally, I’m in this conflicted space where I should go but, you know, maybe it’s more stress than it’s worth, right? Honestly. I think, yeah, I think this is good if they [students] choose to do so. (Chris, member checking)

C. Include family in milestones

Practice: Be intentional in including family in milestones during the qualifying process. The qualifying process in graduate physics programs is no easy feat and celebrating these milestones is important. One easy way to include family is to encourage them to participate in departmental celebration of students’ successes. For example, the department may customarily celebrate a students’ completion of requirements to reach status as a doctoral candidate. In consultation with the graduate student, family or friends may be invited to participate in that celebration. Additionally, some milestones are often open to the public. Departments can be intentional about making things like the dissertation defense hybrid so that graduate students may invite family or friends to witness.

One participant highlighted that implementing this policy is a way to allow family to celebrate the milestones of their graduate student family member.

I think it definitely resonates with me. Not only because getting a Ph.D. and even defending candidacy and like, you know, going through the procedures and processes of a graduate degree are huge milestones, but also because you know. I know that for me for example a lot of my success has been because of the support of my family and my chosen family, I think. And so it is really like important to me that they are there to witness and be a part of the milestones that they helped propel me towards, I think. (Nasir, member checking)

Participants felt that this recommendation could serve multiple purposes including allowing family to see their graduate student family member present their research and a way for the department to demonstrate they care about the graduate students in the program.

Like it's easy enough where you can be like, you know, there's already a public section for like candidacy and what not. So just being like, "oh, yeah, you can also send the link to family members" is a good idea. Like I know my parents would love to see, you know, me give a talk or something. Because there's not really any other chances for them to do so. Conferences are paid, like, entry and stuff like that. And ... Yeah, celebrations too. I mean ... It'll be a little difficult, especially if your family doesn't live nearby. But having the option or just being communicated that your family is welcome is even just that is like a good show, like, we care about not just you, but also the community that supported you. (Deja, member checking)

Some participants felt that implementing this practice would be beneficial to the graduate program as a whole because it would normalize celebrating graduate student milestones.

... what I really like, and I haven't really thought about, but being intentional, including family. And the milestones in these things. Like when I got, when I finished candidacy, you know, it was great you know but even like I barely told my parents "Oh, hey, by the way, I got my master's now." And that should be more of a milestone. I think part of it was just I was glad it was over, but it would be nice if it was just more intentional and not only just including family, but just celebrating it in general. And I feel like we don't do that enough. If somebody was to pass their dissertation and get their Ph.D., there's an email that goes across and then maybe, depending on a particular group, there's like a celebration that people are invited to. But it's almost like an everyday thing and I feel like it could be a lot more and it could be celebrated more. And then even passing candidacy, because that's huge. (Jimmy, member checking)

One participant seemed conflicted regarding including family in milestones during the member-checking interview. While he saw some benefit to including family in milestones, he felt that family might also pressure the graduate student to participate in celebrating milestones when they did not want to do so.

If you want people to believe in this institution ... good marketing doesn't hurt, right? So maybe the

nephew comes in or the niece comes and they see, you know, their uncle or auntie graduate, right? I think that sets a good standard ... I think it's a good community good and a service for people to actually see what that looks like, right? At the same time, it's good for the family to see what all this hard work has been going towards as well as like the student finally getting to put a bow tie on the end of things ... For me personally, I guess a good example is like, I didn't go to my undergrad institution's graduation because I was like, I want to get up out of here, right? But at the same time, when you do that, there isn't a moment where you put the finishing bows on things. Right, because you're just like, fuck it, this place is miserable. Like, I'm ready to get the hell up out of here. And it just worked you down, right? So yeah, I think it's very important that you know not only the student because you're beat down so often that other people come and kind of push you, especially family. They're going to celebrate whatever, you know what I'm saying? They're going to get behind you. Like, "oh, you're awesome. Like you did it, et cetera, et cetera, et cetera." And I think that's um for those of us who aren't as inclined to celebrate, I think that's not a good idea. (Chris, member checking)

Based on the feedback from the participant, we want to emphasize that it is important to include family in milestones only in consultation with the graduate student or to simply facilitate the graduate student being able to choose how to incorporate their family or kin in celebrating their milestones.

D. Mindful messaging regarding family

Practice: Be mindful of messaging regarding family.

The structure and role of family varies across cultures and family dynamics differ from one family to another. These differences reflect complex cultural and social differences [57]. Thus, making statements about the relationship that graduate students should have with their family or kin does not acknowledge the students' unique familial context. To be more specific, faculty should avoid telling graduate students that they need to get used to spending less time talking to family members while in graduate school or making judgments about whether or not a family situation warrants taking time away from classes or research. In alignment with the antideficit framing of CCW, it is also inappropriate for faculty to encourage students to build or strengthen relationships with family members. Instead, faculty members may want to acknowledge the importance of a support system, recognizing that the cultural knowledge, skills, and ways of knowing passed down from family and kin represent strengths that some graduate students bring to their educational experiences.

... this is, I think, a really important point. You know, especially when it's like for a lot of other people it's, you know, I've become of age and I need to take care of myself first and I need to focus on my career and I can't just be going home or doing this and that and the next for family members, you know, they've got to take care of themselves. [It] isn't really a fair opinion to put on everyone. And I think it would also be good to add, as well, that it doesn't just include like, you know, very close members of family. Because that's something I also run into where it's like, you know, if it's not your mom or your dad that's like going through something, then why would you go? When, you know, in previous times, like, I've taken off a job to go help one of my childhood best friends after she got a surgery, right? And it's one of those things where someone would ask, you know, "Why can't someone else help them?" But it's like, well, you know, I have the most time right now. And that's someone I also consider family. So I'm going to do it ... So like other people don't get to dictate who's in that circle of "I need to go and take care of them" or, you know "figure stuff out for them." I think it's important messaging as well. (Deja, member checking)

I guess I was considered more nontraditional. Because when I entered graduate school, I had already had a family and previous careers. And so there was a need for me often as a mom and a wife to spend more time with my family than perhaps many of the other students. And so just having an advisor and people around me who understood that I would be prioritizing my family as well as my studies was, you know, very comforting—knowing that I didn't have to always—I was in a situation where I didn't have to always explain that or I didn't feel like people questioned it. And I guess if I were in a situation where that was something that was challenged or people were questioning if I was spending too much time with my family or why I think that would have really been a hurdle for me in completing my program. (Erika, member checking)

Another participant, Chris, expressed displeasure with faculty perspectives on receiving support from family encouraging doing things on your own and "bootstrapping."

E. Livable wages allow for travel

Practice: Advocate for livable wages and create an emergency fund for graduate students. If graduate physics programs allow for time away to visit family (or use as graduate students choose), but graduate students do

not have the financial support to travel to see family or kin in-person, then the need to maintain familial ties may still go unmet. This may disadvantage students who utilize familial capital as a major resource in their graduate experience. While graduate student wages are not often determined at the department level, physics faculty can advocate for changes in graduate student wages when they are aware that graduate students are not earning a livable wage—one that includes enough funds to occasionally travel to see family, should they need or wish to do so. Some departments have an emergency fund to support graduate students when personal needs arise—which may or may not be related to their family or kin.

Participants felt this was an important implication and many participants shared examples of how financial barriers prevented them from visiting their family even when they wanted to do so.

Like I didn't go home for Thanksgiving this year because, it's like, I'm going back for Christmas and that's already a \$300 flight. And, like, I just can't, like, pull out, like, \$600 in two months to go, like, fly back and forth. Or, it was, like, last year over the summer, like, my grandfather had passed. And, like, I had to, I mean, obviously my family helped with the ticket to go back home and stuff, but, like, not everybody just has, like, family that would be like "oh," you know, "we'll help you pay the \$400, \$500 of like a last minute ticket flying into [City Named]," you know? So it's also hard to build emergency funds, I think, on our current wage, you know, if you don't live in a house with like three other people and spend \$100 on groceries per month. So yeah, so I think having a livable wage, especially one where it allows you to save is important. (Deja, member checking)

Maybe better for graduate students to have higher wages like for example like I can't go home for Christmas this year because I can't afford to because I have other things to pay for. So, yeah, I think like higher wages in general would be better to allow people more access to be able to see their families and like renew their you know desire to continue, I guess, because being close to family really helps ground and center yourself for some people and like keeps you renewed to be able to continue doing what you're doing. (Nasir, member checking)

F. Create more opportunities for family to understand the program

Practice: Include family in orientations and department visits. This particular implication was added after member checking and based on the member-checking

interviews. Multiple participants felt departments should provide more opportunities for family to learn about the department and the research in the program. While one participant felt this could be included in milestones, other participants were clear that this should be in addition to including family in milestones and that this should be a separate implication.

One participant specifically suggested having a welcome or orientation for family so that they could better understand the process their family member would go through in graduate school. This could also be accomplished through creating a department brochure that is aimed at helping incoming graduate students and their families understand the program expectations and milestones.

It would be beneficial for people within the department to understand just a variation of learners, meaning in the sense of, you will often have students who come whose family and parents have no clue what they're doing and why they're doing it. And so in the beginning, initially, there can be that tension that exists between them being off and away from their family and the family kind of not really understanding ... why they're off and what they're doing ... If ... there was some way ... family members could be invited, ... maybe a welcoming when you welcome the new student or also have some type of thing where family could get involved or participate and learn more if they're in the city. Maybe they could even be invited on campus to do a tour of the campus or to kind of see inside what the student is really going through and what they're doing. Also kind of giving them an explanation of what this whole process is like because many times family members just assume it's much like undergrad and they don't understand why you're not off for the summer ... So kind of maybe orientation for families of sorts, even if it was virtual ... something that I know that myself and many other students struggled with when they first started, just getting the family to even understand what the heck you're doing ... So kind of giving them an opportunity to learn more about the program, whether it be, you know, like I said, tours or virtually or just sending out ... an information package or an opportunity to ask questions. (Erika, member checking).

Especially being a physicist, right? Or you're an experimentalist like sometimes the family actually wants to know, like, where were you spending all this time at? And it's like, this is it. Like, this is what I've been doing, right? This is the setup, right? Again, within some limitations, right? In some cases, maybe you spend all your time in a clean room. I think it'd be difficult to get everybody in the clean room, but you know, really

allowing people to see, physically, what goes on and what that process looks like. I think that would be dope. (Chris, member checking)

V. LIMITATIONS AND DELIMITATIONS

In this paper, we draw the findings of our study from excerpts from interviews with eight people who participated in the APS bridge program and member-checking interviews with two of those participants and an additional four participants. While the goal of qualitative research is never to generalize, we acknowledge that the findings included in this paper do not necessarily reflect the experiences or perspectives of all students who participate in physics bridge programs. Additionally, the importance of familial capital may or may not be transferable to graduate students whether they participate in physics programs or not. Thus, the suggested policies and practices that we included in our implications are aimed at the department level with a caveat to check-in with students individually. Indeed, we are employing an asset-based approach in this study; thus, our goal is not to determine which student populations do or do not use familial capital as a resource. Instead, our goal is to help our readers who may be graduate students, faculty, or administrators to recognize familial capital and think about how they might leverage familial capital within bridge programs. To increase the trustworthiness of the findings and implications included in this paper, we engaged in continuous member checking as described in this paper and included excerpts from the member-checking interviews in the findings and implications sections.

This study has been delimited by our choice to focus on familial capital alone in this secondary analysis rather than all forms of capital as we did in our initial analysis. While we focused solely on one form of capital—and familial capital in particular—as a result of suggestions offered during member checking, this was a decision of the researchers that may have an impact on the findings and implications. For example, in our initial analysis, we found that familial capital was often described in tandem with other forms of capital. Thus, that complexity is lost in this analysis. However, the researchers believe this decision better addressed the goal of making familial capital easier to identify by excluding the complexity of identifying familial capital alongside other forms of capital.

VI. DISCUSSION AND CONCLUSION

In this paper, we expound on the CCW framework, a framework often referenced but rarely used in PER. We specifically illustrate familial capital as a form of capital important to and utilized by graduate students participating in bridge programs. Further, this paper contributes to research on graduate education in physics by providing six concrete suggestions for better acknowledging and leveraging familial capital to improve the experiences of

students participating in bridge programs and quite likely any graduate student with familial capital.

While the purpose of the member-checking interviews was to increase the trustworthiness and validity of our findings and implications, there was an additional theme present in those interviews that is relevant to this paper. While participants mentioned this in reference to various implications, all of the participants expressed a desire for support from the department in helping family to understand what graduate school entails—particularly in terms of time commitments, overall culture, and expectations. This may be especially beneficial when graduate students are the first in their families to attend college. Participants felt that such support would strengthen their relationship with family members, allowing their families to better support them in navigating graduate school.

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