Bridging the gap: A sequential mixed methods study of trust networks in graduate application, admissions, and enrollment

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Working Abstract (248/250 words): Undergraduate education in the US is racially/ethnically stratified, and there is limited mobility for Black and Latinx BS recipients in STEM majors into the PhD programs from which faculty hiring disproportionately occurs. Bridge programs are proliferating as a means of increasing minoritized students' enrollment in STEM graduate programs, but little social science examines mechanisms of their impact or how impacts depend on the graduate programs to which students seek access. This sequential mixed methods study of the Cal-Bridge program analyzed trust networks and mechanisms of relational trust as factors in graduate school application, admissions, and enrollment decisions. First, using social network analysis, we examined patterns in the graduate programs to which seven cohorts of Cal-Bridge scholars applied, were admitted, and chose to enroll. Then, we conducted an in-depth case study of the organization in the Cal-Bridge network with the highest centrality: University of California, Irvine's physics and astronomy PhD program. We find the positive admission and enrollment outcomes at UC Irvine were due to intentional, institutional change at multiple organizational levels. Change efforts complemented the activities of the Cal-Bridge program, creating conditions that cultivated lived experiences of mutual, relational trust between bridge scholars and their faculty advisors and mentors. Findings illustrate mechanisms and antecedents of trust in the transition to graduate education. We use these findings to propose a framework that may inform the design of future research and practical efforts to account for the role of trust in inequities and creating more equitable cultures in STEM.

Keywords: *Graduate admissions, trust, decision making, equity*

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1. Introduction

Trust is defined by scholars as the willingness to place one's self-interest in someone else's hands—to accept risks of gains and losses (Kohn, 2008). Trust is integral to the reproduction of social institutions (PytlikZillig et al., 2017), including higher education, where relationships are built on earning and learning trust (Posselt, 2018). *Relational trust,* which is, "the extent to which there is consonance with respect to each group's understanding of its and the other group's expectations and obligations," has been posited as a basis for exchanges of opportunities and resources in educational institutions (Cranston, 2011, p. 62). The transition to graduate school is an apt site to empirically explore how relational trust operates, including its mechanisms and antecedents. Enrollment in graduate school is the result of iterative choices that include student decisions about where to apply, matriculate, and enroll as well as institutional decisions about whom to recruit, admit, and financially support. By the time that a student begins their first day in graduate school, significant energy has already been expended by both the student and graduate program in determining whether trust is warranted.

Like other social relations, patterns of extending and withholding trust are not immune from racism, sexism, elitism, and other systems of power (Vakil et al., 2016), and this is reflected in the institutions to which minoritized scholars tend to be included and excluded. US higher education is a stratified system (Bastedo & Gumport, 2003), and graduates of the broad-access colleges and universities where African American and Hispanic undergraduates disproportionately enroll (Carnevale & Strohl, 2013) have significantly lower odds of progression to graduate school than those who attend more selective institutions (Zhang, 2005). A recent

analysis of the Survey of Earned Doctorates finds limited mobility for Black/African American and Hispanic/Latino BS recipients into PhD programs in the Top-25 ranked US universities from which faculty hiring disproportionately occurs (Fleming et al., 2022, pp. 11-13).

What impedes access to these institutions' PhD programs? Not only do students enrolled in minority-serving institutions (MSIs) and teaching-focused institutions have less access to undergraduate research experiences that are increasingly expected for admission to graduate school (National Academies of Sciences, Engineering, and Medicine [NASEM], 2017), but institutional elitism is rampant in PhD admissions. Professors place greater trust in letters of recommendation from well-known scholars and/or other trusted sources (Posselt, 2018). They also tend to judge PhD *applicant* quality through the lens of their judgment of the applicant's *college* quality (Posselt, 2016). That a university's elite status exerts a "halo effect" on the perceived quality of its students/alumni is well documented (Paxton & Bollen, 2003). Selectivity is central to perceived status, and notions of college quality and selectivity have become so aligned that even education scholars have operationalized "quality" using selectivity metrics such as Barron's competitiveness ratings or average SAT/ACT scores. These tendencies advantage well-connected applicants from a small set of elite colleges and universities, and they disadvantage applicants from Minority Serving Institutions—where large shares of US Latinx, Indigenous, and African-American applicants enroll (Fleming et al., 2022).

Meanwhile, research shows that racially minoritized applicants to graduate school are also involved in assessing risk and trust, but that they consider factors other than status when deciding where to enroll. As they enter STEM disciplines that may have reputations for being toxic, hostile, chilly, or otherwise negative (e.g., Hall & Sandler, 1982; Wilkins-Yel et al., 2019), prospective graduate students make enrollment decisions with the quality of the environment in

mind, including alignment of the environment with essential personal considerations. A key study found that racially minoritized students were more likely to "investigate the academic environment through such activities as talking to other minorities who have been through the program, visiting the campus firsthand, and ensuring that the institution is aware of—and sensitive to—their needs" (Poock & Love, 2001, 217). Conditional on access (i.e., an offer of admission), their trust must still be earned. Statistically, Black, Latinx, and Indigenous admitted doctoral students are more likely than white and Asian counterparts to privilege the following in their decision making: the diversity of the faculty, students, and community; the quality of financial support; interactions with faculty; and the costs of living, child care, and housing (Bersola et al., 2014). A literature has emerged on the role of geographic considerations in graduate school choice for minoritized students, so important are these factors in framing their decisions about whether and where to enroll (Bowie et al., 2005; Ramirez, 2013).

To summarize, we propose that politicized dynamics of trust (Vakil et al., 2016) are reflected in application, admission, and enrollment decisions—and the networks of graduate programs and universities where students are included and excluded. We document patterns of trust in doctoral program applications, admissions, and enrollment through research on a bridge program that is intent on broadening participation of scholars pursuing doctoral education in STEM. To reduce inequalities in doctoral education in STEM disciplines will require graduate programs both to change the patterns of trust in whom they perceive to be admissible and to earn the trust of prospective students from populations that have been historically marginalized or altogether excluded from STEM. In this paper we focus empirically on race, gender, and their intersections, while recognizing the salience of disabilities, sexualities, and socioeconomic status as individual and intersecting factors for access and inclusion. The patterns of trust on the part of

doctoral programs and applicants create trust networks, defined as groups of individuals or institutions in which familiarity and shared norms lead to opportunities for those within the network and devaluation of those outside the network (Tilly, 2005). The formation and maintenance of trust networks, we argue, represent significant, underacknowledged factors in discussions about cultural change in STEM disciplines and graduate programs (NASEM, 2018).

1.1 Literature and Theory

We begin with the assumption that any networks that develop in the transition to doctoral education reflect patterns of trust on the part of prospective doctoral students and professors. Trust is "typically established through repeated transactions, or membership in common communities that enforce rules of behavior" (Orman, 2013, p. 2). Relational trust can support effective collaboration and professional growth when group norms have been established, as uncovered in research with professional learning communities. Cranston (2011) found that principals act as brokers of relationships between faculty, students, and parents. With roots in shared norms and expectations, trust and relational trust in academic organizations is typically discussed as a source of connection and mutual understanding.

However, scholars note that trust also entails a preference for the familiar and, as a result, can stymie innovation and perpetuate the status quo in academia (Tierney, 2008). In addition, when individually biased patterns in whom a person tends to trust aggregate up—and especially when they are encoded in organizational and institutional norms and rules—group-level inequalities result. Examples of racial inequalities that are rooted in so-called "colorblind" dynamics of trust can be found in voting (Haney-López, 2013), criminal justice (Mayorga-Gallo, 2014), and K-12 school discipline (Lewis & Diamond, 2015). In higher education, gatekeeping processes also manifest these patterns. Mistrust in candidates of color interviewing for upper

administrator positions results in their being subjected to filters that white candidates are not (Sagaria, 2002). In a variety of disciplines, universities' tendency to hire tenure-track faculty from a small set of elite universities (e.g., Burris, 2004; Nevin, 2019) entrenches social inequalities, because highly selective institutions disproportionately exclude from undergraduate and doctoral programs low-income, women, and racially minoritized students (e.g., Clauset et al., 2015). In short, perceptions of and actions associated with trust are part of institutionalized racism.

1.2 Trust Networks in Graduate Admissions Decisions

The current study builds on research evidence that patterns of trust in the graduate admissions process create barriers to students from underrepresented groups. In an ethnographic study analyzing graduate admissions committee deliberations, faculty on admissions committees in nine disciplines, including physics and astronomy, relied on individual and institutional trust networks—connections among people and organizations with whom they were already connected. Individually, faculty would trust praise in letters of recommendation more when they knew a letter's author and could attest to the author's credibility (Posselt, 2018). Faculty also used rankings and other sources of information about the reputation of undergraduate institutions to gauge the trustworthiness of an applicant (i.e., that person's likelihood of success if admitted to their program) (Posselt, 2018). A dominant factor specifically limiting admission of more diverse groups of students was professors' risk aversion (Posselt, 2016), including racialized views of whom they constructed as a risk. Professors tended to view applicants with academic or personal profiles different from those of their usual students as "risky." Two major factors drive this risk aversion and further suppress diversity: homophily, the natural attraction of like for like (McPherson et al., 2001), and the related focus on prestige of the institution from which the applicant earned previous degrees (Posselt, 2016). In a context where risk aversion is normative

and racialized, trust is a form of social capital in admissions that "enables faculty to invest in the future of applicants whose relative merits are difficult to determine based on the evidence available" (Posselt, 2018, p. 507). Relational trust and trust networks, in sum, play an important role in shaping enrollment in graduate education via admissions decision-making.

1.3 Trust in Graduate School Application and Enrollment Decisions

The role of trust has not been empirically examined, however, in graduate students' choices about where to apply and matriculate, two decisions which also condition enrollment and attainment outcomes. Especially as programs begin to actively recruit more diverse students, relational trust may be important to understanding patterns in the climate and compositional diversity of programs, universities, and disciplines/fields.

We envision three possible mechanisms by which trust may affect application and enrollment decisions. First, like social networks, shared social categories (e.g., race/ethnicity), can provide a foundation for building trust, especially when people do not know one another (Smith, 2010). In addition, racially minoritized graduate students may relay experiences with a hostile racial climate in a particular PhD program to prospective students of color, reducing their sense of trust that it will be a good place to apply or enroll (Slay et al., 2019). Likewise, positive experiences among minoritized PhD students' in the programs where they enroll may be relayed to prospective students; in this case, positive reputations for select programs may develop and, perhaps, a network of trusted and reputable PhD programs where other prospective students with similar backgrounds are more likely to apply and enroll. Finally, expanding access to professional activities that have become informal prerequisites for graduate school, such as research experience, may shape application, admissions, and enrollment decisions by building prospective

students' trust in professors and current graduate students who may become resources for navigating application and enrollment decisions or faculty trust in applicants' readiness.

1.4 Summary

In the graduate application-admission-enrollment cycle, prospective students and faculty exchange and withhold trust through their decisions, and we assert that patterns in these exchanges are foundational to enduring inequalities in doctoral education. Yet, trust exchange does not occur on a level playing field. Trust requires that the entrusted party has options and freedom of choice (Smith, 2010). Having a reliable pool of applicants ensures faculty the power of choice in admissions, but prospective students are not guaranteed the same when it comes to enrollment. Prospective students may initiate the trust exchange through their applications and the communications that may precede application, but their power to shape the outcome of graduate education transitions is attenuated by faculty gatekeeping decisions.

Historically, exclusive processes of admissions suggest that broadening trust networks is likely to involve rethinking the criteria and means by which applicants—particularly minoritized ones—are deemed worthy (i.e., trustworthy) of admission. Regardless of the scope of their enrollment options, once a graduate student matriculates into a given program, they enter into its trust network and may choose to exercise their membership by participating in the program's recruitment—or not. Cal-Bridge offers an excellent opportunity to study these issues; scholars and current mentors may be brokering relational trust in ways that expand students' confidence, exposure to knowledgeable confidants, and opportunities. Cal-Bridge may also be expanding professors' judgments about who is trustworthy for admissions.

2. Context of the Research

We study a successful bridge program in STEM, which began in the disciplines of physics and astronomy, Cal-Bridge, to document the formation of relational trust networks that support first generation and racially minoritized students' enrollment in physics and astronomy graduate programs. Bridge programs have proliferated as a means of accelerating minoritized students' enrollment in graduate programs, particularly in physical science disciplines (Gámez et al., 2021; Hodapp & Brown, 2018; Rudolph et al., 2019). Though bridge programs follow somewhat different models, they have a common goal: increasing access to doctoral education in fields where typical admissions processes and priorities disproportionately exclude Black, Indigenous, and Latinx students as well as women and first-generation college students.

Cal-Bridge is designed to create a pathway to doctoral education for current undergraduate students from backgrounds that are underrepresented in STEM: physics and astronomy were the only disciplines for the first six years.[1] It was launched in 2014 with support from an NSF S-STEM grant, and is predicated on smoothing the pathway from California State Universities (CSU) (most of which are Hispanic-Serving Institutions) into University of California (UC) PhD programs. Its ultimate goal is increasing the diversity of these disciplines from PhD programs through the professoriate (Rudolph, 2019). To that end, Cal-Bridge identifies promising undergraduates in CSU institutions early in their undergraduate career and offers wraparound supports that include scholarship funds, intensive mentoring, cohort building, professional development, and research opportunities. Among the first seven cohorts of Cal-Bridge scholars, 59% identify as either Black, Latinx/Hispanic, or Indigenous/ Native American. Of scholars from these Cal-Bridge cohorts, 42% are women or nonbinary; 17% are URM women; 19% identify as

[1] In 2020 computer science and engineering were added, and a mathematics pilot is beginning in 2022. However, for this study, we only included data from Cal-Bridge scholars in physics and astronomy for consistency across each application cycle.

LGBTQIA+; another 12% identify as disabled; and 62% are first generation college students. All but one person in our dataset fit one or more of these categories.

Table 1 presents selected application and admissions outcomes by cohort, including the number of scholars applying and admitted to a PhD program for each year of the program, the percent who were admitted to at least one PhD program, and the average number of acceptances per scholar. The last column shows the total for all seven application cycles in which scholars have applied. Over 70% of scholars who applied to PhD programs have been admitted to one or more PhD programs, with an average of 2.5 acceptances among scholars receiving any acceptances. These statistics suggest that the support structure designed by Cal-Bridge is, for most participants, succeeding. This paper investigates mechanisms leading to that success.

Table 1

Cal-Bridge PhD applications and admissions, 2015-2022

	15-16	16-17	17-18	18-19	19-20	20-21	21-22	Total
Number of scholars in this year	4	8	8	13	25	29	40	127
Admitted to a PhD program	4	7	7	10	17	21	26	92
% Admitted to a PhD program	100%	88%	88%	77%	68%	72%	65%	72%
Avg number of acceptances	1.5	2.8	2.1	1.9	2.4	3.2	2.6	2.5

Unique in Cal-Bridge is a mentoring format in which each student, beginning their junior year, is co-mentored by a faculty pair representing physics/astronomy in both a CSU and a UC institution. The hope is that these mentoring relationships, which often lead to undergraduate research experiences at UCs, together with additional professional development activities hosted

at UC's, will encourage scholars to apply to and enroll in UC PhD programs. Cal-Bridge scholars apply to at least 10 PhD programs, at least four of which must be at UCs, further encouraging pathways between the CSU and UC systems. Alongside the formal requirement for scholars to apply to UC PhD programs is an informal hope that UC faculty mentors' engagement with Cal-Bridge scholars from the CSU system will create a halo effect through which UC faculty more positively judge training and students from the CSU system and/or MSIs broadly.

3. Methods

We designed a sequential, mixed-method study to answer the following questions:

1. What networks of graduate program application, admission, and enrollment emerge in the Cal-Bridge program? Which institution(s) are most central over time?
2. What is the role of trust in faculty and student experiences with minoritized students' admissions, applications, and enrollment? How does trust manifest in the most central university in the Cal-Bridge network?

Data collection and analysis occurred in two phases, with results from the first phase of quantitative analysis responding to question one and informing design and data collection for the second, qualitative phase in response to question two (Creswell, 2014). First, we conducted social network analysis (SNA) on PhD applications, admissions, and enrollment outcomes from seven cohorts of participants in the Cal-Bridge Program, with the goals of identifying network patterns, generally, and central organizational nodes, specifically. The SNA highlighted the UC Irvine physics and astronomy PhD program, as central within the networks where Cal-Bridge scholars apply, are admitted, and enroll. In the second phase, we therefore conducted a longitudinal case study of that program to identify mechanisms through which faculty and students cultivated and

expressed trust affecting application, admissions, and enrollment decisions. In what follows, we offer a deeper rationale and explication of these methods.

3.1 Phase One: Social Network Analysis

Social network research provides a method for understanding human behavior, and offers a distinctive approach to exploring equity issues in graduate education. Networks allow researchers to see relationships and connections between and among people in a community (Valente, 2010). SNA is therefore both "a theoretical perspective and a set of techniques used to understand these relationships and how they affect behaviors" (Valente, 2010, p.3). As a theoretical perspective, it provides a lens for understanding how individual people and organizations are embedded in webs of social relations and interactions (Borgatti et al., 2009). As a methodological technique, SNA allows researchers to visualize the strength of relationships among actors within a network and the centrality of some individuals or organizations (Valente, 2010). Its application can demonstrate how a person's place within the network may affect (or be affected by) their behavior as well as how they integrate, or perhaps are allowed to integrate, within that network.

3.1.1 Social Network Data Collection and Analysis

The Cal-Bridge program provided a dataset that was used to track scholars' applications, acceptances, and enrollment in graduate programs between the years 2015 - 2022. The dataset was shared with us as a password-protected and restricted file with student names removed; instead each student was given a number as an identifier (n=127). Our sample includes all Cal-Bridge Scholars who entered PhD programs as the purpose of this study is to investigate influences on PhD program admissions and enrollment.

Other information in the dataset included cohort year, undergraduate institution, race/ethnicity, gender identity, citizenship status, and first-generation college status. To visualize the networks of PhD programs where scholars applied, were admitted, and enrolled, we transferred the data into a separate Excel sheet as a 2-mode matrix with the name of the PhD institution on the x axis and the scholars identified by only their ID number on the y axis. Three separate matrices were created for each application cycle year across the three points of data collection (i.e., application, admission, enrollment). In total, 23 matrices were created to draw 23 separate networks: 21 of the networks documented the first seven application cycles and two additional comprehensive matrices captured the total admission and enrollment networks for all seven years. Additionally, demographic data (e.g., race/ethnicity, gender identity, cohort year, undergraduate institution, citizenship, and first-generation status) for each individual student was input into a separate spreadsheet to document the attributes for each scholar.

We used UCINet 6 for Windows software to input the network data by uploading each of the 23 matrices. Then, using the corresponding NetDraw, we visualized each network. In addition to the visualized networks, we conducted a two-mode centrality analysis on the two comprehensive matrices titled *2015-2022 Admitted network*, and *2015-2022 Enrolled network* of all scholars in all seven application cycles. We compiled reports for the percentage of students *admitted* to a UC campus for each application cycle as well as the percentage who *enrolled* in a UC. We also calculated the percentage of scholars who had three or more graduate school acceptances for each year to identify whether there was a trend of increasing acceptances per scholar (See Table 1 above).

3.1.2 Social Network Measures of Centrality

In networks, the distribution reveals which individuals or groups are most central or popular. Centrality, which can be measured in numerous ways, is the extent to which a person or group "inhabits a prestigious or critical position in the network," (Valente, 2010). Put simply, it measures the number of choices one receives from others in the network. In our case, we wanted to understand which PhD programs became the most central in the Cal-Bridge network as measured by the number of Cal-Bridge scholars who applied, were admitted, and/or enrolled. We offer two measures: The most common measure of centrality is **degree centrality** which is the number of links coming in and going out (Valente, 2010). Degree centrality is calculated as follows (Valente, 2010, p. 82):

$$C_D = \sum \frac{d_i}{N-1} \qquad (1)$$

where C_D is degree centrality, or a measure based on the number of links held by each node or actor in a network, d_i is the number of ties (enrollments) received by a node (PhD program), and N-1 is the maximum number of ties (enrollments) possible in the network. Centrality measures are further distinguished as in-degree (the number of ties received) and out-degree (the number of ties sent out). Our interest in examining the programs that were most applied to, admitted to, and enrolled in meant that out-degree centrality was the most useful measure for us.

A second measure of centrality is Eigenvector centrality, which captures the weighted sum of direct and indirect connections (Bonacich, 1972). By calculating the connections from important actors, or nodes, with more weight than connections from unimportant nodes, the Eigenvector centrality is considered to measure the influence of actors within a network (Golbeck, 2013). In a two-mode matrix like ours, organizations (i.e., a graduate program) and persons (i.e., prospective scholars) are both considered "actor" types and will each have a measure of centrality within the network. Eigenvector centrality explains that a graduate program's centrality is

determined by the sum of centralities of the scholars who listed that program (Borgatti & Everett, 1997). In other words, a program's centrality will be based on the number of scholars who are associated (i.e., who apply, are admitted, or enroll) with the program list that program, and how central those individuals are in the network. In the UCINET program (Borgatti et al., 2002), eigenvector centrality is "normalized by dividing each raw eigenvector score by the square root of one half, which is the maximum score attainable in any graph," (Borgatti & Everett, 1997, p. 257). The UCINET program module implements this process and outputs a value. Thus, the nodes with the highest values communicate the most influence and importance within a network. In our network analysis, we were interested in understanding the program(s) that held the most influence in admissions and therefore only looked at Eigenvector centrality for admissions decisions.

3.2 Phase Two: Longitudinal Case Study

In the second phase, we conducted a case study to better understand (1) how the UC Irvine (UCI) physics and astronomy PhD program became central in the networks of graduate school application, admission, and enrollment created by Cal-Bridge as well as (2) the role of trust in enabling application, admission, and enrollment. A case study, drawing on multiple sources and types of data, is an appropriate method for conducting research on a bracketed process occurring in natural settings (Creswell, 2014). In this case, we wanted to explore trust networks as not only created by faculty communicating about, evaluating, and making decisions on whom to admit but also by graduate students choosing where to apply and enroll.

3.2.1 Sampling and Data Collection

We used purposeful sampling to recruit faculty connected with Cal-Bridge within the PhD program as well as recent participants in and leaders of graduate admissions (Creswell, 2014). We also interviewed other faculty who were recommended to us as leaders for diversity and inclusion.

Graduate student research participants were recruited through emails to a department listserv and student group as well as through the recommendations of student leaders. Individual interviews were conducted with faculty (N=7) and graduate students (N=8), all via Zoom due to the COVID-19 pandemic. Among the graduate student participants, two were early in their PhD program, two were mid-way through, and four were nearing completion. Two of the seven graduate student participants had been Cal-Bridge scholars themselves.

Interviews ranged from 30-60 minutes each. The faculty interview protocol included questions about the role of Cal-Bridge in diversity, equity, and inclusion (DEI) related changes in the program, how Cal-Bridge may have affected evaluation of graduate student applicants, and how trust might factor into evaluation and decision-making differently as a result of Cal-Bridge. The student interview protocol included questions about the role of trust in information seeking while applying to graduate school, trusting influences on enrollment decision-making, and the PhD program's recruitment and DEI efforts.

We gathered additional types of data to provide context for and triangulate with the interview data (Creswell, 2014). For instance, an environmental scan was conducted of the UCI PhD department and program website for messages regarding recruitment, admissions, and climate for diversity and inclusion. In addition, several documents were collected to shine light on admissions, recruitment, and climate: an evaluation rubric for graduate admissions, departmental statements of and plans for diversity and inclusion, a departmental graduate student handbook, and material on graduate student initiated and led activities.

3.2.2 Qualitative Data Analysis

Analysis of the qualitative data was conducted in three stages of coding, which is "the process of organizing data by bracketing chunks" of text into meaningful categories (Creswell,

2014, p. 197). First, transcripts of interviews and in-depth memos conducted immediately after each interview were uploaded into NVivo 12 for open coding, inductively drawing out codes from the participant interviews. During this phase, some initial sensitizing concepts allowed us to group information by its relevance to our study and the components of an admissions cycle: trust (from all interview participants), application (student), admissions (faculty), recruitment (all), and enrollment (student). Other codes emerged as prevalent across participants, including student leadership, program climate, and departmental changes. Next, axial coding was conducted to further bracket and reduce data in response to the research questions, and to relate open codes to one another. For instance, subcodes were created to differentiate mechanisms of trust, such as research experience, familiarity, and Cal-Bridge-students' success. Finally, the trust networks theory was applied to uncover findings that were then triangulated across data sources.

Triangulation involved comparing and contrasting themes from our findings among various sources and types of data, such as faculty and students, as well as interviews, memos, and survey responses, in search of discrepancies and/or confirming information (Creswell, 2014). First, we reviewed thematic differences between faculty and students while noting shared mechanisms underlying our findings (see discussion for more details). Next, we triangulated our findings related to students with data collected from the SNA survey's open-ended questions asking Cal-Bridge students about their application and enrollment decisions. Data from 29 respondents who applied to UCI and 13 respondents who were admitted to UCI were reviewed in conjunction with interview data from the codes "application" and "enrollment" to strengthen our understanding of the factors that applicants considered at these different stages. Finally, analytic memoing from the environmental scan of the website and documents from student-led DEI initiatives supported the interview data analysis.

3.2 Trustworthiness and Protection of Vulnerable Populations

Throughout the research, we have worked to carry out our work in ethically responsible ways, with mindfulness of the racialized labor that research on these issues entails as well as COVID-19 impacts on research participants and research team members alike. Most of the study's student participants come from marginalized backgrounds, as racially and/or gender minoritized people. Among our steps to protect participant confidentiality, we have omitted or abstracted certain details from student data, beyond what is typical, that might have allowed individuals from their program to identify them. For the comfort of student participants in particular, doctoral student authors conducted the interviews with students, without faculty authors present. A faculty author led most interviews with faculty participants. In the course of the work, we have triangulated the data analysis at multiple time points, across sources and researchers. Finally, pseudonyms are used for all participants.

3.3 Limitations

Like all research, this study has limitations. Data collection occurred during the COVID-19 pandemic, complicating multiple aspects of the work, most notably participant recruitment. Only two of the student participants in the qualitative portion of the project were Cal-Bridge scholars themselves, which means that our findings speak less to how Cal-Bridge scholars specifically developed trust in this program (i.e., how UCI came to be central in the Cal-Bridge network) than how students in the PhD program from minoritized backgrounds, generally, developed trust that facilitated their application and enrollment. We consider this a strength from the standpoint of answering the project's research questions and theoretical generalizability. Lastly, we acknowledge that any categorizations such as "minoritized" entail significant

heterogeneity that are not accounted for with precision in our findings due to the commitment to protect participant confidentiality.

3.4 Authors' Positionalities

The four authors hold different positionalities on several salient dimensions, including race/ethnicity, gender, professional status, and field. The first author identifies as a Chicana scholar and educator concerned with how higher education organizations create, maintain, and perpetuate inequities affecting racially minoritized students and faculty. The second author is a white education professor working in research, administration, and change efforts on graduate education; these different roles come with discrete perspectives on barriers to equity. The third author is a Latinx postdoctoral researcher in education with experience studying graduate admissions and diversity, equity and inclusion policies and practices in higher education, which informs their attention to student agency and equity labor. The fourth author is a white man who has taught for 15 years at an institution in the California State University system, and who founded and directs the Cal-Bridge program to support underrepresented students in STEM and diversify the pathways into graduate education. The points of commonality and divergence amongst us have created a rich context for collaborative project design and meaning making.

Our intersectional identities within our respective institutions made us mindful of the positions of power we held inquiring about trust among vulnerable populations of graduate students from minoritized backgrounds. As such, we exercised care with participants during data collection in ways such as: (1) verbally providing statements about our positionalities prior to each interview to develop trust; (2) allowing participants to choose their own pseudonyms reflective of their gender and ethnic identities; and (3) matching across rank between participant and interviewer to avoid power hierarchies that might manifest between roles such as professor

and graduate student. In addition, we emphasized across many periods of time that the findings of this research was not meant as a programmatic evaluation.

4. Findings

The findings are organized into two sections, with the Social Network Analysis followed by the Longitudinal Case Study.

4.1 Phase One: Social Network Analysis

Tables 2 and 3 present the Degree and Eigenvector centrality of the top admitting and enrolling PhD programs for Cal-Bridge scholars between 2015-2022 listed by university name. Across both measures of centrality, UC Irvine admitted the most students and was the most influential in the admissions network. This analysis illustrated that across all seven application cycles (2015-2022), UC Irvine was a case worthy of further investigation.

Table 2

Network Centrality Measures for Top Admitting PhD programs, 2015-2022

	Out-Degree (Rank)	Eigenvector (Rank)
UC Irvine	0.123 (1)	0.782 (1)
UC Santa Cruz	0.051 (2)	0.271 (2)
UC Riverside	0.043 (3)	0.263 (3)
University of Wyoming	0.036 (4)	0.177 (4)
Penn State	0.022 (5)	0.134 (6)

Not only were faculty on the UCI admission committees choosing to admit more Cal-Bridge scholars than any other graduate program in the network, Cal-Bridge scholars were also choosing to enroll at UC Irvine more than any other graduate program in the entire network.

Table 3 displays the Out-Degree centrality and rank order to confirm that scholars chose to enroll most often at UC Irvine. Although we included Eigenvector centrality in our analysis, only one campus, UC Irvine, had an Eigenvector measure indicating that it was at all influential. Essentially, this measure of centrality is determining UCI's influence because, of the programs where students chose to enroll, UC Irvine was the choice for more scholars in the network. Other programs formed smaller clusters of Cal-Bridge scholars (See Figure 1 for network visualization).

Table 3

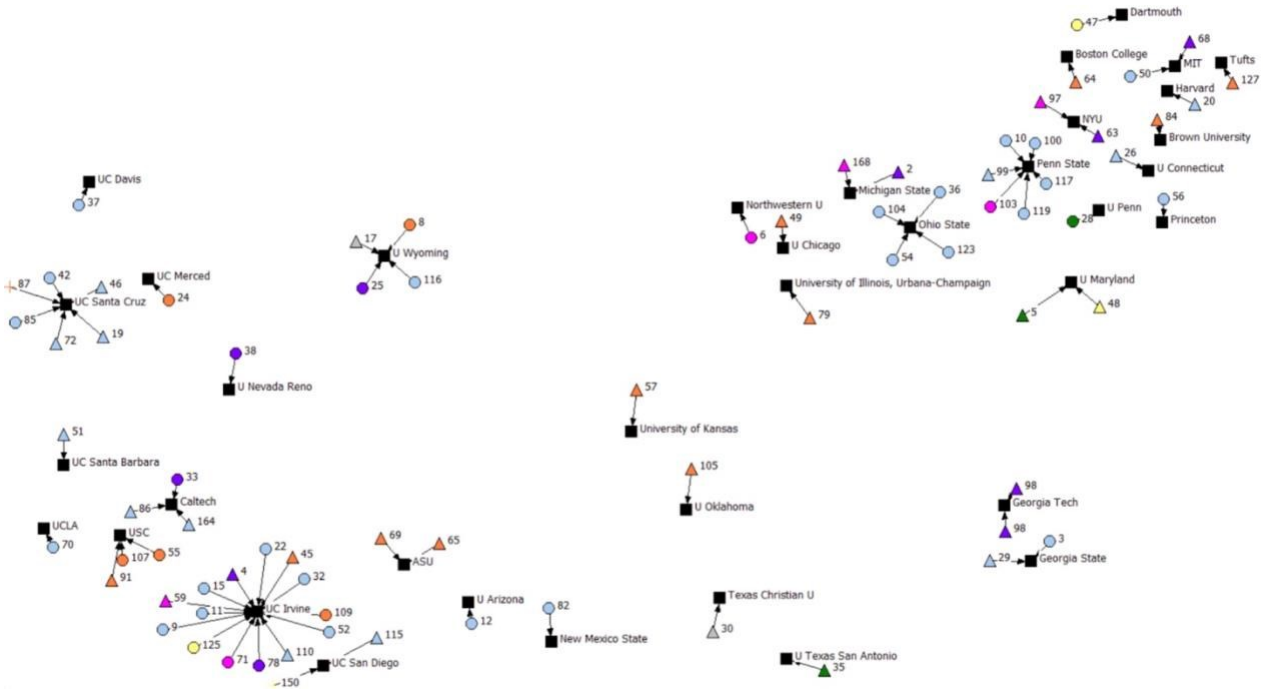
Network Centrality Measures for Top Enrolling PhD Programs, 2015-2022

	Out-Degree (Rank)	Eigenvector (Rank)
UC Irvine	0.102 (1)	1 (1)
Penn State	0.044 (2)	-
UC Santa Cruz	0.044 (2)	-
University of Wyoming	0.029 (3)	-
Ohio State	0.029 (3)	-

In the network visualization of the PhD programs where Cal-Bridge scholars enrolled (Figure 1), the universities are depicted spatially in a way that corresponds roughly to the geographic area where they would be found on a map of the United States. Because we know that network trust occurred for both Cal-Bridge scholars and the faculty at UC Irvine who admitted them, we decided to explore what factors influenced their trust in phase two of the study.

Figure 1

2015-2022 Cal-Bridge PhD Program Enrollment Network



Note: The black squares represent universities. Gender identity is represented as follows: triangles represent Women, circles represent Men, plus signs represent non-binary individuals. Ethnicities are represented as follows: Pink represents Asian American, Blue represents Hispanic/Latinx, Yellow represents Black/African American, Orange represents white, Green represents American Indian, Purple represents Native Pacific Islander, Gray represents multiracial.

4.2 Phase Two Findings: UC Irvine Case Study

The case study's goals were to understand how UC Irvine became a network hub and the role of relational trust in that process. Phase two findings from the case study are organized around admissions, applications, and enrollment decisions. We uncovered two sets of themes concerning the role of trust in the UCI physics & astronomy program's development of greater compositional diversity, one centering on faculty admissions decisions and the other centering on student application and enrollment decisions. The faculty admissions data elicited three themes about the program's development of trust in 1) a context of changing admissions policy and the impact of Cal-Bridge, 2) new types of applicants via the adoption of holistic review, and 3) the

role Cal-Bridge played in helping change the calculus of "taking risks" when making admissions decisions. Student interview and survey data revealed a second set of themes about student trust in mentors and their networks to guide application decisions as well as solidifying enrollment decisions, and the uncertainty of other factors in which students may entrust their decisions absent academic mentors. We first present the themes related to faculty trust in admissions processes, then student trust in application and enrollment processes.

4.2.1 Trust Dynamics Influencing Admissions Decisions

4.2.1.1 The Right Changes at the Right Time: Program Admissions in Context

A clear finding in our data is that the Cal-Bridge program catalyzed change in the UCI physics and astronomy PhD program given already-evolving conditions that were occurring in both that program and the university. At the same time that a national dialogue around admissions in astronomy was calling into question reliance on the GRE, leaders at UCI were launching initiatives to diversify the faculty and student populations. These initiatives were part of a decade-long Inclusive Excellence campaign, led by the central UC Irvine administration. Within the department of physics and astronomy, some faculty on the admissions committee were ready to embrace these broader shifts even when it meant an informal policy of ignoring scores automatically collected by the school. Neil, faculty, referred to these tactics stating, "we were kind of ahead of the curve, I think, on that, like getting rid of the GRE. We were doing that before it was cool." Physics and astronomy faculty also had an explicit goal of growing the size of the PhD program. This combination of conditions were ideal for Cal-Bridge to help broker trust in new types of applicants. Cal-Bridge developed capable junior researchers, generated relevant information about research experiences the UCI program required for a new, holistic admissions process, and worked with trusted faculty colleagues from UCI and across the UC system. By

design, Cal-Bridge created a pathway for candidates that met exactly what faculty at UCI were seeking under the new admissions policy.

4.2.1.2 New Information Used in New Ways

To enact UCI's broad organizational priorities around growth and inclusive excellence, faculty in physics and astronomy saw an opportunity to change their recruitment practices and their admissions process toward a more holistic model. This holistic approach included, but was not limited to, the removal of the GRE requirement for admissions, evaluation of student success over time in relevant undergraduate coursework, and a greater focus on research experiences. Because of the national dialogue around the GRE, some UCI faculty reconsidered its utility in admitting students for the first time, while other faculty members had long advocated dropping it from admissions considerations altogether. For instance, Lee stated the problem with relying on GRE scores for admission is that "records related to standardized tests are not related to research but are requisites for research." This results in what Robert referred to as "mismatch" given that the assessment is made on "sketchy information." Although Robert believed that there was informational value to be gleaned from the physics GRE, they pivoted away from using the score as a disqualifier and instead made decisions with a new set of information. Robert shared, "we've decided actually just to not even accept the GRE physics test, and that's because of the other things we know about its bias." This reframing, they added, "improved the diversity of our cohort from about 10 percent to about 40 percent or so." Additionally, the transition to a more holistic review of applicants included a re-framing of how GPA is used. Whereas it was once used as a numerical qualifier or disqualifier, the department shifted to look at the whole transcript as opposed to focusing on GPA alone. Mark shared that they "go in and look at the operation physics courses and the math courses [to] see how they've done over time." The program's

adoption of holistic admissions coincided with the Cal-Bridge collaboration, opening up new possibilities for faculty trust in admissions decisions as shown in the findings below.

4.2.1.3 "The Question Mark now turns into a Check Mark": A Cycle of Trust

Within the UCI physics and astronomy program, faculty reported that Cal-Bridge gained an initial foothold, in part, because it was able to capitalize on existing faculty trust networks and change the calculus of "taking risks" when making admissions decisions. This Cal-Bridge effect operates by removing uncertainty in the area of research and, over time, creating a bridge of successful students from which faculty base their trust on future Cal-Bridge identified applicants.

Cal-Bridge collaborations with UC faculty benefited students by bringing them into the fold of larger, existing networks. Lincoln illustrated the importance of networks by stating, "obviously you have colleagues from other institutions and [friends] you trust if they tell you this is really a truly outstanding student. In some regards way more than others." Sam asserted that admissions committee members' early consideration of Cal-Bridge students was facilitated by familiarity: "I think they trust us as their faculty peers…And because we vouched for the program, they were willing to listen." UCI faculty collaboration with Cal-Bridge, therefore, helped initiate trust in its students.

An important consideration in admissions is identifying prospective graduate students with the ability to conduct research that will potentially have major implications for moving their field forward. As Robert put it, "The thing that we are trying to do when we recruit PhD students is obviously find people who can do research." The PhD is, after all, a research degree traditionally intended to produce the next generation of scientists and professors. Another faculty member, Mark, stressed that they are trying to gauge how well a prospective student understands the field through their discussion of research in the application materials, and they indicated the

role of Cal-Bridge in that regard: “I think Cal-Bridge really does help because a lot of the times the students are interacting with their faculty members who, if they're doing their job right, will give them some sense of [the field].” In sum, Cal-Bridge faculty mentors, especially research mentors, help guide students into the discipline and what it is to be a researcher.

Not only in UCI, a common admissions challenge involves the misalignment of information in application materials with evidence of ability to do the all-important task of research. David challenged that it was “never really clear how much useful information [the physics GRE] was giving about applicants that you didn’t already get from looking at grades and transcripts.” Collaborating with and reviewing applications from Cal-Bridge scholars was an epiphany for Robert, who said, “if someone's been doing research for the Cal-Bridge program, we actually have information about the thing we care about the most.” Evidence of Cal-Bridge scholars’ abilities to conduct research also comes directly from their research mentors, who can provide compelling letters of recommendation. Mark stated, “The thing that, really, Cal-Bridge does is it gives students an opportunity to research, to get connected with researchers in their field, in their area who can then write letters for them.” This professor’s comment highlights that Cal-Bridge provides access to relevant research experience and a strong faculty network, which operate as reinforcing resources that are greater than access to either one alone.

An applicant’s participation in Cal-Bridge allows faculty to feel confident in making admissions decisions that might once have felt like a risk. Robert may have summed up this point best: “Cal-Bridge allows you to see the person doing research and the question mark now turns into a check mark.” Sam agreed that Cal-Bridge made it easier for the admissions committee to know who had the ability to do research. Cal-Bridge provides students with the research experience that faculty want them to have, along with mentorship that prepares them to present

their research in their applications in a compelling way, while providing faculty with precisely the data they need to determine that an applicant can do research at the doctoral level.

UCI also has high rates of admitting Cal-Bridge scholars due to its early track record of enrolling doctoral students whose academic success reflected back on Cal-Bridge glowingly. Mark stated, “The trust we built is not just because I know the people in the Cal-Bridge community, I know what they're doing; it's also because the students who have gotten through this program have done really well.” Because the earliest cohorts of Cal-Bridge students that attended UCI set an example of success, faculty have been apt to continue trusting the quality of training that Cal-Bridge provides students. Recognizing additional benefits, Neil commented, “the students we're getting are just extraordinarily motivated, and they step up, and they rise, and they are doing so much in terms of service to the department.” Students from Cal-Bridge have not only been models of success, they have become leaders going above and beyond to improve their program for all students regardless of how they joined. Amy pointed out that these students have garnered recognition beyond their campus as well: “They are excellent. They have a very high number of getting NSF [Graduate Research Fellowships]. I would say that’s sort of the turning point.” The external validation of the Cal-Bridge alumni at UCI provides the program faculty with a sort of calibration that affirms the trust that faculty have placed in these students. Robert declared, “Look, if we have good experiences with a Cal-Bridge student, we should be going after them and trying to make it very attractive for them to come to UCI.” This faculty member brings the trust full circle to the Cal-Bridge program and future students it will train.

4.2.2 Trust Dynamics Influencing Application Decisions

To this point, we have reported on trust dynamics that shape faculty capacity and inclinations to trust in the admissions context. Among the doctoral students at UCI whom we

interviewed, we learned that the ability to incorporate trust into their application process is a privilege. Our student interview participants' and survey respondents' application decisions were pragmatically driven; their research interests and location preferences were critical. Because applicants' desired locations were tied to personal considerations, they did not need to consult anyone other than, perhaps, their immediate families. These considerations varied widely and entailed things such as remaining close to family, residing in racially diverse cities, and concerns about crime and safety. Decisions about where to apply that were based on what doctoral programs would best fit prospective student's research interests, however, often involved trust for applicants who had people in their lives with insider knowledge of their field. Mentors from undergraduate research experiences, such as Cal-Bridge, were a resource that students trusted for these insights.

4.2.2.1 Trusting Mentors and Advisors

Applicants generally prioritized particular fields of research when searching for information on doctoral programs to which they might apply. For instance, Lily stated, "I was mainly looking for programs that had a strong particle experiment program." This student had a clear idea about their research interests and independently set out to identify programs that could meet their needs. Navigating this search can be difficult for any undergraduate since they have not had a lot of time to familiarize themselves with their chosen fields. For Lily, this certainly played a role in their limited awareness of UCI as an option: "I didn't really know much about it. I think my advisor said to apply because he knew one of the faculty at UCI. So, he's heard of the program." When talking about why they trusted this person they said, "my research advisor just, you know, knows the field, he knows all the people, so he knows who's doing what in each university. So, I took his opinion into account." Lily understood their advisor as a source of

greater knowledge about the field and therefore imbued the advice with trust. Another student, Don, trusted a mentor from an undergraduate research experience to provide information about applying to doctoral programs that they had no other access to: “her opinions guided me through the process. I’m [a] first-gen student and I had no idea of the process going in, and so she was invaluable to my success in getting into a graduate program.”

Another student also relied on the insider knowledge of a Cal-Bridge faculty member at UCI to guide them to their current doctoral program: “So he knew that this—my [current] advisor was looking for someone, and he knew of me. So he decided to link us together. And I ended up applying to UCI.” Terry, who works in a narrow specialization, revealed that they had not initially considered UCI, stating, “It was actually the last school I applied to. And the reason why was because, at first, I thought UCI did not have anyone that I wanted to work with.” Through the Cal-Bridge collaboration and connections to the UCI program, Terry was connected to a faculty member in a program that was not an obvious fit in terms of the student’s research interests but which ended up working out for both the student and their current advisor. This student benefited from the Cal-Bridge faculty member’s knowledge of the field within the UC network to broker out-of-the-box connections. The student also began to extend trust from the Cal-Bridge faculty whom he was familiar with to that person’s trusted colleague—a theme that we explore next.

4.2.2.2 Extending Trust in the Familiar to Their Networks

Some students based trust on personal familiarity or by extension to those trusted by people with whom they were familiar. Cal-Bridge and other research experiences could provide students with interactions over time that allowed them to develop familiarity based trust across a wider network. Taylor remarked, “I think I really wanted to go to UC Irvine because I had done a summer internship here with my current research group and I was like, ‘wow, this seems like a

really nice place.'" By doing research over an entire summer, Taylor was able to build familiarity with graduate students that led them to trust UCI as a worthwhile place to apply and to rank it highly among potential schools. Taylor continued, "The grad students were really, really supportive and always were willing to help me and stuff like that. So that was really nice." Importantly, while getting to know potential colleagues, Taylor had positive interpersonal experiences at UCI. They were not the only one in our sample to express this. Chris also shared, "in terms of the grad students and you know the faculty here at UC Irvine that helped me out I think I had just developed a relationship with them over that summer and so I just came to trust them over time that way." While Stephan did not have an opportunity to do research at UCI, their trusted undergraduate advisor was familiar with faculty there. Applying to UCI was an easy choice for Stephan because, "knowing that [the doctoral advisor] is a nice person and…my [undergraduate] advisor, he just talked, like, very good things, he said very good things about him." Through Stephan's familiarity with their undergraduate advisor, they were able to extend their trust to someone whom their advisor knew personally and praised highly.

Not all students had relationships with experts in their field, let alone access to an extended trust network. For Julian, who was not a Cal-Bridge scholar, the doctoral application process was a lone endeavor the first time around. They stated, "I didn't really have a mentor or advisor in undergrad. So it was just mostly what I saw online, like the Grad Café and Physics Forums and PhysicsGRE.com and stuff like that." Julian was resourceful in seeking out information online but had no one to trust to in determining "which schools were good or which schools were bad" for them given their interests and goals. After an unsuccessful attempt with admission, Julian applied again—this time with some support from colleagues they trusted because, "they have PhD's and were pretty successful." For applicants, the PhD application

process was imbued with trust via familiarity with faculty or others in their fields. By getting to know faculty and current graduate students through summer research experiences and other mentoring, applicants learned information not available through public, impersonal resources, such as the internet.

4.2.3 Trust Dynamics Influencing Enrollment Decisions

If the potential to make application decisions based on personal trust is a privilege not afforded to all applicants, then the potential to bring trust into deciding where to enroll is even more dependent on circumstances—namely, whether hopeful applicants have more than one offer of admission that allows them to choose where to enroll. Even applicants with only one offer of acceptance to a doctoral program still considered whether it could meet their needs, and assessed this through similar trust mechanisms. As we describe below, for participants in the fortunate position of being able to choose UCI instead of another program, the most common deciding factors were rapport with their future advisor, research fit, location, and the campus visit. The latter was, in part, a vehicle for meeting with a potential advisor, current graduate students, and potential members of one's future cohort. Funding was also consequential for some students regardless of acceptance to one or more programs. Of these considerations, the relationship with the advisor, the campus visit, and funding were imbued with trust developed in a variety of ways. Familiarity, for admitted students with access to field-knowledgeable counsel, strongly continued to affect student trust, whereas transparency played a more tacit role.

4.2.3.1 The Familiar and the Transparent

At least two participants in our study continued to extend trust that had been developed through familiarity during their application decisions into their enrollment decisions. For example, Stephan made their decision to enroll based on rapport built with their doctoral advisor,

who happened to be a friend of their undergraduate mentor that made the introduction. They gushed, “we talked a lot on e-mail, and even with other faculty, so I was like—yeah, I love this place. [Laughter] I don't know, like, I just, it made me feel very comfortable.” They continued, “I knew that the good call was to get here.” After applying to UCI as a function of trust in their undergraduate mentor, Stephan continued cultivating a relationship with the potential doctoral advisor and began to directly trust this future advisor. Taylor talked about being recruited during the campus visit after being accepted to the PhD program: “Everyone tried to convince me individually to come here. Everyone, my lab group at the time. I was like, ‘Wow. People really want me to come here and I like these people already.’” The connections that this prospective PhD student made with current graduate students clearly swayed their decision-making about where to enroll. For students who were able to begin building trust through connections made during the earlier stage of applying, those connections and the trust they engendered remained among the most important factors in students’ enrollment decision stage.

Students described mixed experiences about developing trust in relation to transparency, funding, and graduate student representatives. For instance, Terry shared: “In terms of funding, he didn't sugarcoat it. He said that he has to apply and everything, and that he's hopeful. And I think that was enough to say, ‘Okay, you're hopeful. Let's just—I'll hope too.’” Even though funding was crucial for Terry, they appreciated their advisor’s frank assessment and that he did not ‘sugarcoat’ the circumstances with false promises. Whereas Don disclosed that while the UCI program offered them a departmental fellowship, they did not receive anything about the financial offer in writing, “which was kind of—it seemed like it was a little iffy, so I had to keep asking to make sure that that would be included. Because that [the fellowship offer] was the main deciding factor between UCI and [another school] in the end.” This student wanted a written guarantee

because finances were a major concern in their decision-making. Without it, they were averse to trusting the program. As at least one faculty member guessed, transparency is a mechanism to earn student trust. And students are savvy enough to understand that transparency entails documentation of promises as well as being upfront about inability to make a promise.

4.2.3.2 The Campus Visit

Students described mixed experiences about the possibilities of forming trust, based on the diversity they observed and interactions with graduate students at the campus visit. For some prospective students, witnessing diversity at UCI campus visits informed their decision to enroll, in part, through trust of graduate student representatives and how they portrayed the program. Lily talked about how the campus visit impacted their decision to go to UCI:

> But I think what made me go with UCI was that I saw, at least on the visit day, there was a lot of women. So, that would be my cohort; those would be the people I would be spending most of my time with. So it was maybe okay if there wasn't as many women, you know, in the upper years.

Even though Lily observed that the program as a whole was not especially diverse, they trusted that they would experience a positive climate because the cohort had a relatively strong representation of women. Another student's campus visit to UCI a couple of years later, however, yielded a contrasting impression. Julian said:

> Most of them weren't BIPOC students. They were definitely all white or male Asians, so it's a completely different experience for me anyways. Because I've seen people be treated completely differently just for their skin tone being a little bit darker.

Julian had a hard time trusting graduate student representatives' positive views of the program due to their social identities. Prospective students who identified with the backgrounds of the PhD

students they saw at the campus visit, whether based on race, gender, or both, were more likely to trust in the chances of having high-quality experiences once enrolled.

Trust in graduate student representatives at campus visits was not guaranteed. Don took a relatively trusting stance:

> He's just another grad student. I didn't feel like he had much [reason] to lie to me in terms of trying to get me to come to UCI, because ultimately it doesn't really benefit him, at least not that I'm aware of. So, yeah, you're gonna trust him a little more than a professor.

For Don, graduate students, unlike faculty, did not have a stake in whether or not students chose UCI, so they had no reason to be anything less than forthcoming in their descriptions of the program. Yet, Julian was skeptical of graduate student messages that, "UCI is not that bad," and "You guys should come here." Instead, Julian presumed, "For the open house, I don't think the people that actually have bad experiences at UC Irvine go to those." Julian did not disagree with Don's assessment that graduate students were being truthful about their experiences, but rather questioned whether they represented the full spectrum of student experiences in this program.

The trustworthiness of current students at recruiting events, then, is not only a matter of representing the field or the racial/ethnic and gender diversity of a program, but also of representing the quality of experiences. In fact, two interviewed students who talked about negative experiences relating to inclusivity and racial equity in the program admitted that they did not, and would not, participate in student recruitment because of these trust-damaging interactions. Faculty were aware of these dynamics to some extent, as Lee acknowledged: "A few years back, we had students refusing to participate in the recruitment, because they feel it was unethical because their experience was so terrible." Yet, when students with positive experiences readily step up to support the campus visit, prospective students may not become aware of mixed

experiences with a program's climate until they matriculate, if that is what they decide. For instance, Sandra, who stated that "the community here [at UCI] is very close-knit and welcoming and supportive," participated in campus visits and, at their advisor's request, spoke to admitted students who were considering joining their research group. Sandra suggested that student representatives at the campus visit are "usually very honest," with prospective students and willing to say, "No, don't work for this professor," if there is a known issue. Therefore, although the program did not handpick graduate student representatives, there is truth to Don's presumption that students in the program self-selected into recruitment activities, like the campus visit, based on the quality of their experiences.

5. Discussion

The purpose of this study was to understand the networks and dynamics of trust in graduate school applications, admissions and enrollment, particularly within a statewide bridge program that is intent on broadening participation of scholars pursuing doctoral education in physics and astronomy. Through social network analysis of 127 students' transition into graduate education, we identified the UC Irvine physics and astronomy PhD program as the most central destination for Cal-Bridge scholars in this growing network. With this information, we carried out a case study of the UC Irvine physics and astronomy department to understand from the perspectives of both faculty and students how the department came to be central, and the roles of student and faculty trust in making that happen. Due to students' and faculty's distinctive positioning relative to trust, the themes emerging from analysis of faculty and student data diverged. In dynamic interaction were two sets of cultural priorities and preferences: those of faculty that led to admissions decisions, and those of minoritized students that contributed to their application and enrollment decisions.

From faculty, we learned that rising attention to diversity, equity, and inclusion within the program, university, and discipline gave the program confidence in making changes to their admissions process that would reduce barriers to Black, Latinx, Indigenous, low-income, and women applicants. In this changing landscape, and because California Proposition 209 precluded direct consideration of race, faculty saw eliminating the GRE requirement as a significant policy decision. It both changed the terms of access and signaled to prospective students the program's openness relative to PhD programs in physics and astronomy that were holding the line on their admissions practices. Cal-Bridge emerged during this time as a natural complement to admissions reform efforts. Some faculty respondents in our research said that Cal-Bridge not only aligned with movements for change in the program, school, university, and disciplines, but also provided a means of acting on emerging commitments to institutional change.

If the changing landscape helped UCI faculty trust the plausibility of new processes for determining access, generally, the Cal-Bridge mentoring and research training changed the calculus of risk-taking as experienced by faculty considering Cal-Bridge scholars for admission. As the data show, Cal-Bridge reduced ambiguity about the trustworthiness of applicants outside the UCI faculty's typical institutional trust networks and profiles that some faculty might not have recognized as trustworthy. Faculty came to see that preparation for the research-centered work of graduate school mattered most, not high test scores or degrees from elite universities, while also appreciating the letters of recommendation attesting to such research skills that often came from familiar researchers. In this respect, being in relationship with Cal-Bridge scholars helped faculty see beyond undergraduate institutional prestige, shifting the focus to applicants' experience with research and broader readiness for doctoral level training.

No single factor led to the Cal-Bridge program building trust. Instead, the Cal-Bridge program brokered complex processes that led mostly white faculty at UCI and other PhD programs to admit minoritized scholars from comprehensive state schools. To achieve these results, several features of the program operated in interconnected and mutually reinforcing ways: 1) the early engagement of UC faculty in selecting and mentoring the scholars as undergraduates, as well as acting as undergraduate research mentors; 2) the guidance provided by UC mentors in helping Cal-Bridge scholars learn the "hidden curriculum" of how to present themselves as future researchers in their applications; 3) the trust built across the department through recommendations of colleagues who have worked in the program; and 4) the success of the Cal-Bridge program and its scholars over time. The Cal-Bridge program has existed for nine years, and with each additional year, PhD programs that have accepted Cal-Bridge scholars who succeed leads to a deepening trust in scholars from the program and, possibly, other minoritized scholars.

The context of this research in a bridge program and our data from both faculty and students add to research evidence about the role of trust and trust networks in the transition to graduate school. We found that the first few Cal-Bridge scholars who enrolled at UCI played an especially important role in catalyzing a network hub there, and faculty repeatedly mentioned them positively in interviews. Those students and their success effectively created a bridge that enhanced faculty trust in the admissibility of subsequent Cal-Bridge scholars who applied to the program. Although judging applicants through the lens of their impressions of other students with one or more similar traits is a cognitive heuristic, it hardly constitutes best or fair practice in evaluation. Psychologists call this tendency attribution bias, and it is especially problematic when one makes comparisons—as in this situation—on the basis of a small sample of cases (Kahneman, 2011). We do not suggest that because UCI used Cal-Bridge students as a testing

ground for checking their biases, and greater diversity resulted, that other institutions should think of admitting bridge students as a strategy for disrupting faculty biases. Every student deserves the right to participate simply as a student.

We found that dynamics of trust also imbued students' decisions about where to enroll, including developing rapport with a prospective advisor, belief in the testimonies of current graduate students during campus visits, and confidence in one's future financial wellbeing via funding offers. For the scholars, the Cal-Bridge program and its alumni community provided a network of information about PhD programs, faculty, and program climates. In this regard, prospective students' trust in the quality of climate as relayed, implicitly and directly, by current students was crucial. Similarly, Slay and colleagues (2019) found minoritized students may exercise power over enrollment outcomes by relaying hostile racial climates to prospective students and deterring them from enrolling in particular programs. Our study documented not only students who participated in campus visits and recruitment stating a willingness to give specific, critical feedback but also the refusal to participate in such activities by some PhD students who had significant negative experiences in the program. Although students may opt out as a principled stance or matter of self-preserving boundary setting, doing so means that prospective students will not have access to the fullest spectrum of student experiences with a program's climate prior to making enrollment decisions. By choosing to participate in recruitment activities, current graduate students are empowering themselves to act as trust brokers for the next generation of doctoral students.

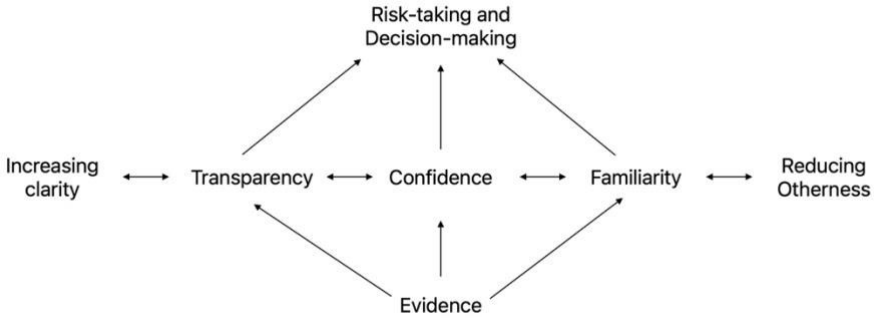
The mechanisms underlying student development of trust in programs aligned with those that enabled faculty to trust prospective students. *Familiarity* continued to play a strong role from the student perspective in forming relationships (at the individual advisor and program level), as

did *transparency* about key information, and *evidence* of diversity. Although few students whom we interviewed had many choices about where to enroll, that decision entailed some degree of *risk-taking*, just as faculty perceive admission of any applicant to involve some risk. We found that to create more diverse enrollments required faculty at UCI to confront what they had thought of as "other" and/or inferior. This confrontation required learning to question the default sense of trust that they had placed in certain applicant metrics or credentials while also learning to trust students from broader access undergraduate institutions.

With respect to theoretical contributions, then, our findings add to understanding about mechanisms of trust development in institutional contexts (see, for example, Hamm et al., 2016; PytlikZillig et al., 2017). Figure 2 outlines relationships among students, faculty, and trust observed in our qualitative data that could provide the grounds for hypothesis development in future research. Transparency (a cognitive mechanism) and familiarity (an affective mechanism) both emerge from the availability of information or evidence where it had previously been absent. However, transparency contributes to trust via confidence emerging from new information, while familiarity contributes to trust by reducing a sense of otherness that may come with the information available.

Figure 2

Mechanisms and Antecedents of Trust in the Transition to Graduate Education



To be clear: the prevailing dynamics of trust and trust networks in higher education are clearly politicized. They uphold racial, class, gender, and other social hierarchies. Like racial and economic systems of power, these dynamics are more than attitudes (Tilly, 2005), they are legitimated and institutionalized through the organizational mechanisms used to determine access and advancement. Vakil et al. (2016) write,

> establishing trust with community partners, especially in communities that serve non-dominant groups, requires not only a personal working relationship but also a political or racial solidarity… Trust nor solidarity is gained (nor should it be) by the assertion of good intention, nor is it accomplished merely once and then set aside. Instead, politicized trust calls for ongoing building and cultivation of mutual trust and racial solidarity. It is thus a trust that actively acknowledges racialized tensions and power dynamics" (p. 199).

With this provocation to a deeper engagement with the politics of trust, we suggest that what Cranston (2011) called relational trust may often also be racialized. Minoritized students may perceive graduate education and the academy as places that do not feel like they are "for them." These institutions have reputations to overcome (Dobbins, 2020). Although the tendency to trust in affinity groups may seem more pronounced among people from marginalized backgrounds, racial/ethnic bonds are a common foundation for particularized trust in dominant and minoritized

groups (Smith, 2010). The tendency for white men applicants to implicitly trust in the predominantly white men faculty and students who traditionally characterize STEM doctoral programs, however, is rarely discussed.

5.1 Implications

A major implication of this study is that the colleges and universities where large numbers of minoritized undergraduate students enroll need to be incorporated into the trust networks of faculty in PhD granting institutions. In this case, a formal partnership brokered by the Cal-Bridge program between California State University and community college campuses, most of which are HSIs or MSIs, with physics and astronomy departments across the University of California and outside the state (Cal-Bridge Partners) served this purpose. Our evidence suggests that part of UC Irvine's success was due to the program's growth just as diversity had become a mainstream goal at the national, institutional, and departmental levels. The timing and conditions were ideal for admitting and enrolling Cal-Bridge scholars. The program supplied them with just what they wanted: students who would both contribute to diversity and who would be viewed as trustworthy within the context of changing admissions norms. The scholars' research experience and mentoring from known academics in the field, for example, provided UCI faculty with things that they had already been seeking.

5.1.1 Implications for Practice and Policy

In terms of implications for specific practices and policies in graduate education, we find evidence that faculty members in PhD programs may need to shift their perceptions of risk and trust when evaluating applicants who come with profiles that are different from what they usually admit. The opportunity for UC Irvine faculty to engage in close mentoring of Cal-Bridge scholars, combined with the success of Cal-Bridge alumni who enrolled in their PhD, helped faculty shift

these perceptions. Academic departments should be seeking out opportunities to engage undergraduates from marginalized backgrounds in research experiences, and ensuring that faculty who mentor them are equipped with skills and racial literature to support the students' wellbeing.

In addition, PhD programs need to engage in a more comprehensive set of efforts to demonstrate the quality of their learning environment as safe for otherwise marginalized students. Programs like Cal-Bridge that "supply" students from historically marginalized backgrounds may be well-positioned to help change the rules of the game by actively encouraging asset-based perspectives about historically marginalized students. Moving away from GRE scores and other single metrics motivated program faculty to see more deeply into applicants' potential, noticing their motivation, distance traveled, and preparation for the work of research that graduate school would entail. These qualities have also been found to be important criteria of a holistic review process that increases opportunities for racially minoritized students (Barceló et al., 2021).

5.1.2 Implications for Future Research

The mechanisms of trust underlying decisions associated with the transition to graduate education that we identified in Figure 2 could be quantified and modeled using path analysis or structural equation modeling. Understanding student needs might be helped by examining whether the strength of these paths differ between students making application and enrollment decisions and faculty making admissions decisions. In addition, variance in path strength could be analyzed by the race/ethnicity and other social identities of the individuals making the decisions. Our data indicate, for example, that evidence and experiential knowledge are foundations for making decisions that require trust. The role of evidence in building confidence is clear in our data, as are the moderating roles of transparency and familiarity. Whether these processes are generalizable in other settings is worthy of investigation and can clarify how to engage students in

decision making that meets their needs while engaging faculty in decision making that complicates conventional notions of risk.

Our findings regarding student perceptions of trust in application and enrollment decisions indicate new areas for exploration, particularly about relationships between trust and agency among racially minoritized doctoral students. For example, research could explore what the conditions are within programs that lead current PhD students to feel confident or cautious speaking candidly to prospective students about their experiences. Research could also compare the influence of trust and other relational considerations in graduate school choice relative to financial, geographic, and status considerations—either in an idealized sense or when an applicant has multiple institutions from which to choose. Methods from Bersola et al. (2014) could be deployed with insight about trust networks from our study on a multi-institutional basis to understand the generalizability of findings about minoritized student decision making.

Finally, returning to the social network analysis that grounded this research, research is needed at a national level to understand which universities are successfully facilitating minoritized students' application, admission, and enrollment—both in general and in specific fields and disciplines. Which institutional actors within disciplines are the most central or influential? What are the trust networks of such institutions, as illustrated in their graduate school admissions processes, including student origins and origins of letters of recommendation? What can other institutions learn from those that are centralized in those trust networks? The absence of nationally generalizable graduate program-level data continues to be a major challenge for research on graduate education, and its collection may be a prerequisite for such studies as this.

6. Conclusion

The bridge metaphor underlying Cal-Bridge and other bridge programs reflects a constructed connection between sectors of the science system that too often are separate, to the detriment of equitable access. Cal-Bridge helps connect undergraduate and graduate education, as well as MSI's and research universities. In practice, we find that a key mechanism by which Cal-Bridge helps create these sector level connections is by creating a space for the development of trust where it might not otherwise have existed. Some organizations are clearly more engaged than others in the project of relationship building that affects admissions, application, and enrollment of minoritized students who have been excluded from academic networks. At UCI, we found the opportunities for relationship building in Cal-Bridge fit into a broader project of changing how faculty assess who deserves access and changing how admissions operate. In this work, we found enrolled students play a crucial role. Although the notion of a bridge from undergraduate to graduate education underlies the vision of the program, trust helps create the bridge.

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