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# Cultivating Social Capital In Undergraduate Research: Key Sources And Distinctions By Gender

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CULTIVATING SOCIAL CAPITAL IN UNDERGRADUATE RESEARCH:  
KEY SOURCES AND DISTINCTIONS BY GENDER

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Heather Daniels

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CULTIVATING SOCIAL CAPITAL IN UNDERGRADUATE RESEARCH:  
KEY SOURCES AND DISTINCTIONS BY GENDER

by

HEATHER ANN DANIELS

THESIS

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## **Abstract**

Women are outpacing men in overall educational attainment, however this is not the case in science, technology, engineering, and mathematics (STEM) fields when women fall behind men. Establishing strong social connections is important to retention in STEM fields and persistence in the STEM pipeline. This study qualitatively examines what serves as social capital in STEM-focused undergraduate research and how social capital is accrued and deployed differently by men and women in ways that could be contributing to the gender gap in STEM. 17 students participating in external summer research programs at 12 different universities were interviewed at 3 points in time. Results revealed that formal faculty research mentors, roommates, and research team members serve as social capital for students by being listed as references, building professional vocabularies, enhancing students technical and conceptual skills in their fields, and cultivating the students' science identity. Gendered differences arose when examining how students coped with research independence, the amount of psycho-social mentoring they received, and the importance of gender concordance with their mentors. Specifically, men students' engagement in masculine strategizing that embraces research independence in the research training environment without much psycho-social mentoring, and in frequent informal interactions, may be benefitting men in undergraduate research and STEM overall. Gender concordance with mentors provided an advantage for women, even if they adopted non-masculine strategies. Considering gender concordance in the matching strategy prior to the summer research experience may improve student experiences. Furthermore, workshops that emphasize the importance of building social capital for women and men mentees can inform and motivate students to develop strong connections even during short summer experiences.

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## **Chapter 1: Introduction & Literature Review**

While women graduate from college at higher rates than men, they are less likely to major in science, technology, engineering, and mathematics (STEM) and work in STEM fields. This is also the case for Latinas. These inequalities warrant continued attention if the US expects to compete on a global scale in terms of STEM innovation. Structured undergraduate research programs have been created in response to the persisting inequalities in STEM as an attempt to level the STEM educational playing field and to plug the leaky STEM pipeline. Undergraduate research is an important practice for promoting student success in STEM fields and students who participate in these programs benefit from their participation in myriad ways.

Faculty and peers that comprise students' academic social networks and serve as their social capital are important to student success in higher education and in STEM majors, as well as in undergraduate research programs. Pierre Bourdieu's framing of social capital is particularly useful in aiding understanding the gendered ways in which students' social networks operate as they navigate the field of undergraduate training programs, which is the focus of this paper. Little is known about exactly how men's and women's social capital influences their success within these programs. Given that women have fallen behind men in their pursuit of STEM degrees, the ways in which women gain and use social capital may disadvantage them during their undergraduate research experiences and ultimately in their pursuit of a STEM degree, but this has yet to be investigated.

Sociological research focused on educational inequality has yet to fully utilize Pierre Bourdieu's theorizing on social capital to understand how differences in social capital might be contributing to gender disparities in STEM. We know that gender matters in STEM and that social

networks are important influences on student success, but we do not know if (or how) social capital is contributing to the gender gap in STEM. This qualitative analysis of first and second year STEM undergraduates at a Hispanic majority institution is particularly useful to understanding how social capital is enabling and constraining students as they progress along the STEM pipeline. The findings from this thesis aim to inform the design of undergraduate research training programs and to help in closing the gap between men and women within the STEM pipeline.

### **1.1 The gender paradox in higher education and in STEM**

Currently women have surpassed men in terms of their enrollment in higher education, undergraduate degree completion, and graduate school enrollment within the United States (Buchmann and DiPrete, 2006; Diprete and Buchmann, 2006; Diprete and Buchmann, 2013; Conger and Long, 2010; DeBerard, Spielmans, and Julka, 2004). The underachievement of men in college can be traced to many factors. These include family dynamics that do not encourage the academic engagement of boys (Diprete and Buchmann, 2013), peer interactions that promote academic resistance for boys (DiPrete and Buchmann, 2013; Legewie and DiPrete 2012; Van Lier et al., 2005; Riegle-Crumb, Farkas, and Muller, 2006), lower reading test scores for boys (Buchmann, DiPrete, and McDaniel, 2008), and gender performance norms (Kindlon and Thompson, 2009, Morris, 2012). Related specifically to gender performance norms, Morris (2012) revealed that the ways in which boys perform masculinity, what he terms “contrived carelessness,” contributes to the underachievement of boys in their pre-college years. Boys performing contrived carelessness enact a masculinity that supports academic disengagement since being too engaged in academics is viewed as effeminate. When boys were academically successful, their teachers read their success as natural talent, not as something they worked hard to achieve. Conversely, women performed femininity in such a way that promoted strong academic engagement and

teachers often pointed to the amount of work these students put in to obtain their academic success (Morris, 2012).

In STEM, the gender gap is reversed and women lag behind their counterparts who are men (Griffith, 2010). Women are significantly less likely to declare a STEM major upon entering college when compared to men (Mau, 2016; Wang and Degol, 2016). Close to half of employed college graduates are women, but only around 25% of employed STEM degree holders are women and 20% of STEM degree holders working in STEM specific jobs are women (Beede et al., 2011). Prior to entering college, a lack of parental involvement that promotes achievement and confidence in science fields for girls (Halpern et al., 2007, Tenenbaum, 2008; Nosek, Banaji, and Greenwald, 2002), having fewer high achieving peers that are girls to motivate academic achievement and advanced course taking (Riegle-Crumb, Farkas, and Muller, 2006; Zimmerman, 2003), and in-classroom experiences that enrich boys' science identities while discouraging girls (Gerber and Cheung, 2008; Abu El-Haj, 2003; Legewie and DiPrete, 2012) are factors that help explain why women are less likely to pursue STEM majors in college. Upon entering college, women sometimes face discrimination in STEM fields and feel like they do not belong (Carlone and Johnson, 2007; Ong, Wright, Espinosa and Orfield, 2011; Jones, Ruff, and Paretti, 2013). Furthermore, the lack of women role-models (Astin and Sax, 1996; Marx and Roman, 2002; Blickenstaff, 2005; Carlone and Johnson, 2007; Drury, Siy, and Cheryan, 2011), reduced participation in undergraduate research training programs (Harsh, Maltese, and Tai, 2012), and concerns about potential future conflicts between family and work (Han, Sax, and Kim, 2007; Hawks and Spade, 1998) also help explain the persistent gender gap in STEM fields.

This gendered paradox between women's success in higher education more generally and their lack thereof in STEM fields specifically is mirrored among Latina/o college students.

Latino/as are an important group nationally in the US as it is estimated that by 2040 Latina/o's will comprise 30% of the U.S. population, making them the majority group in many states (U.S. Census Bureau, 2008). Additionally, Latina/o students are underrepresented in STEM fields (U.S. Commission on Civil Rights, 2010). While Latino/a students are equally as likely to express interest in majoring in STEM when compared to white students, they are significantly less likely to earn a degree in a STEM field (Chen, 2009; NSF, 2009). In terms of the gendered paradox, Latinas have better academic outcomes when compared to their Latino counterparts who are men (Cole and Espinoza, 2008), but they still fall behind their Latino men in terms of their enrollment in STEM majors, degree completion and employment in STEM careers, with the exception of biological sciences (NSF, 2007). Similar to the literature on the overall gender gap between men and women in STEM, literature specific to Latina/o students has mostly focused on pre-college factors (Oseguera, Hurtado, Denson, Cerna, and Saenz, 2006; Seymour, 2000; Elliott et al., 1996). At the college level, family support that promotes men's interest in science (Anaya & Cole, 2001; Cole & Espinoza, 2008) and "chilly" male-dominated STEM environments on campuses (Hurtado et al., 2007) are particularly relevant to understanding why Latinas leave the STEM pipeline (Chang, Sharkness, Hurtado, and Newman, 2014; Crisp, Nora, and Taggart, 2009).

Most of the previous research on race/ethnicity and the STEM educational pipeline focuses on the differences between white and black students (Lundy-Wagner and Valerie, 2013; Kokkelenberg and Singha, 2010; Palmer, Maramba and Dancy, 2011) and the majority of research on Latina/o college students has tended to treat them as a monolithic group without regard to how gender and other attributes (like nativity or social class) can differently shape their experiences. Although some studies have examined Latina/o students persisting on the path towards a STEM degree (e.g., Crisp, Nora, and Taggart, 2009; Cole and Espinosa, 2008) understanding the gendered

dimensions of undergraduate Latina/o students' navigation and persistence in STEM fields warrants additional attention.

Having strong social networks in the form of faculty and peers are important to student success in higher education and in the STEM fields, however not all of these networks are uniformly positive. Faculty are generally positive influences for students overall during their college careers (Pascarella et al., 2004; Pascarella and Terenzini, 2005), in addition to having a positive impact on Latina/o student success (Cejda and Rhodes, 2004; Museus, Palmer, Davis and Maramba, 2011; Palmer, Maramba, and Holmes, 2011). Engagement with peers in formal as well as informal settings is also positively associated with student success independent of student ethnicity (Pascarella et al., 2004; Pascarella and Terenzini, 2005). Peer networks have been shown to be particularly important contributors to Latina/o student success (Hurtado et al., 2009; Palmer, Davis, and Maramba, 2011), as well as to persistence towards a STEM degree (Peralta, Caspary, and Boothe, 2013). In terms of social connections that may be detrimental for STEM persistence, the experience of having negative or antagonistic interactions with faculty has been shown to discourage students whom originally had STEM aspirations (Blickenstaff, 2005; Chang et al., 2014). Additionally, peers who lack similar educational aspirations can drag high achieving students' academic performance down (McCabe, 2016). Thus, the specific relationships students form with faculty and peers are important when looking at their influence upon students' persistence in college and in STEM majors, generally and for Latina/o students in particular (McCabe, 2016; Kuh et al., 2010; Cole and Espinoza, 2008; Hurtado et al., 2007).

## **1.2 Undergraduate Research Programs**

Gender and racial/ethnic disparities in STEM higher education have led to the creation of numerous federally and privately funded undergraduate educational intervention programs over

the past three decades in the U.S. Many of these programs focus on providing research experience since it has been shown to increase retention in STEM fields and students who participate in these programs benefit from their participation in a variety of areas. For example, undergraduate training programs centered on faculty-mentored research projects have been shown to increase participants' active learning, self-confidence, and pursuit of science careers (Lopatto, 2007, Lopatto and Tobias, 2010). Research experiences also increase students' critical thinking and communication skills (Bauer and Bennett, 2003; Hunter, Laursen, and Seymour, 2007; Seymour, Hunter, Laursen, and DeAntoni, 2004). Undergraduate research participants are thus better prepared to become science professionals than their peers (Laursen, Hunter, Seymour, Thiry, and Melton, 2010; Thiry, Laursen, and Hunter, 2011). However, little is known about how social networks through these programs influence men's and women's experiences and success.

One common arrangement of undergraduate research training programs is for students to participate in summer research experiences away from their home institutions. Similar to academic term undergraduate research training programs, students stand to benefit from participation in these programs in myriad ways. Previous literature has reported on student benefits from summer research programs such as an understanding of research processes, learning research skills and techniques, and increased motivation to pursue graduate studies in STEM (Lopatto, 2004; Hunter, Laursen, and Seymour, 2007). Moreover, these summer experiences can be particularly impactful for minority and women student participants, providing them with tools necessary to succeed in the culture of academia, as well as helping them to view graduate school as an achievable goal (Prunuske, et al., 2016; Lopatto, 2007; Lopatto, 2004; Harsh, Maltese, and Tai, 2012). Specific to summer research, women participants reported greater learning gains than men (Lopatto 2007), but men and women did not differ in terms of their intentions to continue their education (Lopatto,

2004). Considering the lack of previous research on gender, social networks, and undergraduate research programs, this paper advances knowledge by investigating how social networks function to constitute social capital and influence student success, and how social networks are gendered in impactful ways as men vs. women navigate these programs.

### **1.3 Social Capital**

Pierre Bourdieu's framing of social capital might be particularly useful in aiding understanding the gendered ways in which students navigate the field of undergraduate training programs. Pierre Bourdieu viewed modern society as one based on relations of power and he introduced the concept of social capital, which he theorized can provide advantages in the form of resources and networks. While he nested this concept within a broader framing regarding the reproduction of social inequalities, for the purposes of this paper, I am going to focus only on social capital (Bourdieu, 1989). Given that women are falling behind men in their pursuit of STEM degrees, it may be that women students are gaining and using social capital differently in ways that disadvantage them via undergraduate research experiences, but this has yet to be investigated.

Social capital includes the networks of connections and associates that can be used to secure or advance a person's position on the social ladder in a given field. More specifically, Bourdieu (1986) defined social capital as: "...the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition" (pg. 51). This type of capital operates within defined borders of social space and can be used to reproduce existing relations of power and domination. For example, a student from a socially privileged background engaged in undergraduate research may be interested in applying to graduate school after graduation. If this student's mentor provides him with connections to faculty in the programs of interest and helps him to apply to these



programs with letters of recommendation, then this mentor is serving as social capital for the student in the context of academia. This relationship then is reproducing existing relations of power by giving this student access to this form of capital while excluding those from other backgrounds who do not participate in these programs or who do not engage with their research mentors.

Bourdieu's framing of social capital is not the only way in which social capital has been used in sociological research. There are other conceptions of social capital which have been used to study college students' success, such as Coleman (1988) and Putnam (2000). These theorists' concepts of social capital are similar to Bourdieu's in some ways, such as how all agree to some extent that social capital can be a tool used for exclusion and inclusion. Scholars using Coleman and Putnam often report positive associations between social capital and educational outcomes (Klevan, Weinberg, and Middleton, 2016; Gonzalez, Stoner and Jovel, 2003), negating inequitable transmission of institutional resources and opportunities based on embedded structures of power and domination such as race and gender (Dika and Singh, 2002). Unlike Bourdieu, Coleman and Putnam present social capital as a relatively automatic, non-field specific, resource that involves the process of gaining advantages through the application of social capital. Although useful to understanding social networks, these framings lack the explicit recognition of the ways in which social capital is context specific rather something static that is similarly available in all contexts (Bourdieu 1986; Stanton-Salazar, 1997; Lareau 2016).

Unlike Putnam (2000) and Coleman (1988), Bourdieu (1986) was clear that the value of social capital is context specific rather than generally applicable. A student's professor, for example, can function as powerful social capital for getting into graduate school, but he/she is much less useful in terms of helping the student to successfully plan her wedding. To understand Bourdieu's ideas about social capital, one must first understand field. A field is understood as a

social arena that individuals navigate and struggle through in the pursuit of resources and power. Within fields, the institutional “rules of the game” are always changing as actors compete for resources. Given this core characteristic of struggle and change, Bourdieu emphasized the need to view social agents as acting relationally within fields and to conceive of fields not as static structures but as changing social systems (Lareau, 2016).

Previous research has applied Bourdieu’s framing of social capital to examine mentoring relationships and disparate outcomes for students in overall educational attainment and in research training programs both prior to college and once students enter college (Smith, 2007; Ovink and Veazy, 2011; Stanton-Salazar, 1997; Stanton-Salazar, 2001). Stanton-Salazar’s (2001) book reveals how low-income Mexican-American high school students from immigrant families are constrained when accessing and forming social capital due to socially-embedded fear and mistrust as well as by institutional forces (e.g. school policies). Once in university, receiving mentorship has been shown to enable racial/ethnic minority and first generation college students to access social capital (Smith, 2007). Previous research has shown that Latina students acquire social capital via undergraduate research programs and that mentors enable them to continue on the path towards graduate school (Ramirez, 2011).

#### **1.4 Sources of Social Capital in Undergraduate Research**

Research mentors, roommates or peer networks, and research team members are all potentially important sources of social capital for students participating in undergraduate research programs. The literature has identified faculty research mentors as social capital for STEM students engaged in structured research programs (Stolle-McAllister, 2011; Strayhorn, 2010; Ovink and Veazy, 2011). Research mentors serve as social capital by helping students network with others in their field (Stolle-McAllister, 2011); by introducing the students to the norms,

values, and the language of the scientific field (Stolle-McAllister, 2011); by providing them access to social networks that help them gain admission into graduate school (Ovink and Veazy, 2011); and by providing advice about STEM career paths (Stolle-McAllister, 2011). Qualitative research examining alumni participation in a structured research programs aimed at the educational enrichment of minority students within STEM revealed that research mentors contributed to the overall success of minority students continuing on in the sciences and pursuing advanced degrees (Ovink and Veazy, 2011). Given that the studies on the influence of gender on mentor-mentee relationships have not been specific to STEM and research mentors, it is not clear how gender influences social capital building in student-research mentor relationships in STEM, given the gender paradox between STEM and other fields of higher education.

The gender of the student and faculty member may play a role in the student-professor relationship. Results are mixed regarding whether students benefit from having a faculty mentor who shares the same gender or race. Some previous studies have identified faculty mentors from similar backgrounds as particularly important to students who are women and students of color (Stout, Dasgupta, Hunsinger, and McManus, 2011; Syed, Azmitia, & Cooper 2011; Zirkel, 2002; Lockwood 2006; Feeney & Bozeman 2008; Foley et al. 2006), while others believe there are significant advantages for women and ethnic minority students who are mentored by white men, since the mentees can benefit from the mentor's access to power and sponsorship within the predominant culture (Dreher & Cox 1996; Sosik & Godshalk 2005). Findings from one study not focused on STEM revealed that women were more satisfied with their interactions with professors (of either gender) when compared to their counterparts who are men (Kim and Sax 2009). It remains unclear, however, if gender and racial (in)congruence between students and

faculty mentors plays an important role in the formation and functioning of social capital for students within STEM fields.

Peer networks have been identified in the undergraduate research literature as important forms of social capital for students. Hurtado and colleagues (2009) examined four different institutions with academic and summer structured research programs and revealed that the peer networks created by Latina/o students aided them in getting through the programs. When discussing the collaborative aspect of her research training programs and how peer-networks can be useful within the field of an undergraduate research experience, one student stated: “The students are really kind of like the support network here. The students really help each other. I know if I needed something and my advisor wasn’t going to give it to me, I’d definitely go to any of the students, and I know students who are ahead of me, and just talk to them about that” (Hurtado, et al., 2009, Pg. 202). Such peer networks can be conceived of as forms of social capital. Outside of the literature on undergraduate research, recent work has problematized a one-dimensional (i.e, uniformly positive) view of peer networks. McCabe (2016) pointed out that the peers who make up students’ networks can be harmful as well as beneficial, based on the characteristics of the networks. Students who report having smaller, closer peer networks that were aligned with their interests and could motivate them within their educational pursuits are at an advantage. Conversely students who have large peer networks that can provide social support but may not have the same education aspirations, may actually harm students’ academic success (McCabe 2016). This suggests that peer group dynamics may contribute to the underrepresentation of women in STEM fields, but more investigation from a social capital perspective is needed.

In undergraduate research experiences, graduate students, senior undergraduate students, post-docs, and research staff (called “secondary mentors” in this paper) often take on the most

prominent roles in mentoring undergraduate researchers (Gonzalez, 2001; Dooley, Mahon, and Oshiro, 2004), since they interact with new undergraduate research trainees more frequently than do formal faculty research mentors (Thiry and Laursen, 2011; Feldman, Dvill, and Rogan-Klve 2013; Linn, Palmer, Baranger, Gerard, and Stone, 2015; Burgin and Sadler, 2016). These more senior members of research teams often provide lines of communication between undergraduate research trainees and formal faculty research mentors. Undergraduates have reported gains from their engagement with secondary mentors in their acquisition of technical and conceptual skills and their professional development (Aikens et al., 2016; Dolan and Johnson, 2009; Dolan and Johnson, 2010). However, the complex advantages and disadvantages of undergraduate student participation in multi-mentored research team environments has been understudied. It has been suggested that research teams that are tightly organized and meet regularly over long periods can more positively impact student learning of methodologies and concepts than more independent, loosely knit and ephemerally structured teams (Feldman et al. 2013; Burgin and Sadler, 2016). Delamont and Atkinson (2001) explored research team dynamics and asked graduate students to reflect on their time participating in undergraduate research experiences; results revealed that the relationships created in these research teams had a positive impact on developing students' research self-efficacy and comfort with independence in the lab. Dolan and Johnson (2010) explored perceptions of undergraduates, secondary mentors, and faculty mentors involved in research teams and the benefits and disadvantages of these experiences. Undergraduates discussed how their secondary mentors helped enhance their technical and conceptual skills, which helped them build research self-efficacy; students reported a sense of comfort and relatability with their secondary mentors that enabled them to cultivate more productive relationships with their formal faculty mentors (Dolan and Johnson 2010). Gendered differences in students' perceptions of their

research teams, how team members may serve as sources of social capital, or how gender concordance with secondary mentors may affect student mentees have not been examined via prior studies.

### **1.5 Contribution to the literature**

Previous studies have uncovered a gender paradox, with women fairing worse than men in STEM fields even though they generally perform better in college. However, little is known regarding how gendered forms of social capital may influence uneven outcomes for men vs. women in STEM fields, especially during the crucial first years of the undergraduate educational experience. The early years of college are crucial for students who initially chose STEM fields, since most who exit STEM pathways do so during that period of time. Undergraduate research programs have been shown to increase student retention in STEM fields, and students who have positive experiences in these programs within their initial years of college may find that their interests in research are solidified, which strengthens their determination to persist onward towards a STEM degree and career. However, students who face challenges within these programs during their first year are more inclined to exit the STEM pathway and pursue other majors and careers (Chang et al., 2014; Chang, Cerna, Han, and Sáenz, 2008; Chang, Eagan, Lin, and Hurtado, 2011; Hurtado et al., 2007). There is a lack of knowledge on Latino/as, since most research focused on retaining minority students in STEM has focused on whites vs. blacks. There is a troubling gap in our knowledge because we know that gender matters in STEM and that social networks are important influences on student success, but we do not know if (or how) social capital influences the gender gap in STEM. Undergraduate research experiences in STEM provide an ideal context for addressing this gap, since it is well known that these generally help retain students in STEM fields (Kuh et al., 2010). Little is known about how social capital functions to solidify STEM

career motivations, moreover it is unclear how social capital may be gendered in ways that amplify or buffer the early challenges experienced by women in STEM fields.

This thesis qualitatively explores the experiences of 17 first- and second-year STEM undergraduate students from a Hispanic-majority university (HMI) attending external summer research programs at 9 different institutions. Using in-depth interviews with the students at three points in time (before, during and after their experiences), I examine how social capital accrues and functions differently for men and women students as they navigate their research experiences. I address the following questions: What serves as powerful social capital for students as they navigate their external summer research experience? How is social capital cultivated differently by men and women as they navigate their external summer research experience? By addressing these questions, I aim to clarify the role of social capital in enabling and constraining men and women as they progress along the STEM pipeline and, in practical terms, to draw on my findings to suggest approaches for summer research training programs that may help close the STEM higher educational achievement gap between men and women.

## **Chapter 2: Data and Methods**

### **2.1 Participants**

The 17 students participating in this research project are freshman and sophomore students who received scholarships via the GROW research training program at the HMI under study and who were selected to leave the institution for a summer research experience. GROW is a pseudonym for a research training program, used to protect confidentiality of participants.

### **2.2 Study Context**

GROW is a federally funded program designed to train the next generation of researchers who traditionally are underrepresented in STEM fields (e.g., Hispanic students). The program accepts freshman, sophomore and junior students, but freshman and sophomore students are the focus here. Freshman students participate in a college readiness camp the summer before their first semester of college where they engage in preparation for calculus, statistics, writing, verbal communication, reading comprehension, and financial literacy (Collins et al., In Press). Their first-year experiences include enrollment in courses aimed at forming their science identities as well as immersing them in real-world research experiences. Specifically, during their first semester in the program, freshman students are required to enroll in a “Research Foundations” course (RFC), which fulfills a core curriculum requirement at this institution. This course is designed to engage students in critical thinking, help them to understand of the research process, and provide exposure to interdisciplinary perspectives. Sophomore students either enroll in the RFC, if they have not already taken its equivalent, or participate in a two-week compressed version of the course for no credit in August before starting their sophomore year.

Following their participation in the RFC, freshman students then enroll in 2 course-based undergraduate research experiences (CUREs) and sophomores enroll in at least 1 CURE. CUREs



offer students authentic research experiences as part of their required curriculum, by immersing them in authentic research projects while developing relevant skills, acquiring practical experience, and entering a community of practitioners. The goal of the CUREs is to help students form their identities as biomedical research scientists at an early stage of their academic development. During the participants' first year in the program, CUREs were offered in chemistry, biology, psychology, and electrical engineering.

GROW students are required to participate in 10-week mentored summer research program (SRP) coordinated across 12 research partner institutions and their home institution. The partner institutions are primarily located in the US Southwest. Approximately two-thirds of students in the program attend one of these partner institutions each summer, while one third of students remained at their home institution for their summer research experience. For the purposes of this paper, I am focusing only on students who left their home institutions for their SRP. In order to match students with mentors, faculty mentors are recruited at each institution and asked to complete a profile within a customized online platform; students also complete profiles. An algorithm is employed based on research interests, discipline, student preference for location, and the number of slots available in order to match mentors with mentees for their summer experiences. The scholarship program pays the students a modest monthly stipend, as well as their food, lodging and travel expenses while they are away.

In our best attempt to provide confidentiality to the students participating in this study, all identifying information has been masked. For example, student's real names were changed to pseudonyms and only the state of the institutions they attended for the summer have been provided. Students' majors were also omitted from this thesis and only their respective colleges (e.g. college

of engineering) has been provided. Lastly, the year in which they attended the summer program has not been provided, although the interviews were conducted recently.

### **2.3 Study Design and Data Collection**

A three wave study design was implemented in order to understand the students' experiences before, during and after their external summer research placements. Utilizing this design enables analysts to examine changes through time (Kumar, 2011). The data collection was Institutional Review Board-approved by the HMI under study. Initial baseline interviews were conducted during a fall semester when 27 freshman students were interviewed. The interview guide (see Appendix A) asked students to reflect on their experiences in GROW so far, such as their participation in the college readiness camp and CUREs discussed above. Additionally, students were asked questions about their expectations for mentoring in general, their personal background, how they became interested in science, their understanding and identification as researchers/scientists, their family expectations, their social class standing, their long term goals, and their fears and challenges in terms of being scholarship students.

During the spring semester of that same year, these 27 students were matched for their summer research experiences either at their home institution or at one of the partner sites. 14 freshman students (11 women and 3 men) were assigned to summer research experiences outside of their home institution and so I selected them for inclusion in this study. Because of my interest in students' gender and how this shapes their overall summer experience, more men were needed for this study. Therefore 3 sophomore men attending the SRP outside of their home institution were recruited and baseline interviewed at the end of that spring semester, creating a total sample of 17 students. Demographic information about each student is included in Table 1.

In-depth mid-point phone interviews were conducted during the fifth week of the research experience for all 17 participants (see Appendix B). Within this interview, students were asked to reflect on their summer research experiences directly. Students were asked to discuss the research they were engaged in, reflect on their relationships with their mentors and other individuals in their labs (graduate students, post-docs, undergraduate students), making connections with others inside/outside their lab setting, their identification as a scientist relative to their baseline interviews, their families' feelings on their participation in this scholarship program, the skills they have gained through their participation, and challenges they have encountered during their summer experiences.

Upon their return to their home institution, a third and final in-depth interview was conducted (see Appendix C). This interview focused on students' overall reflections on their external summer research experiences. Students were asked questions designed to clarify changes in their mentoring relationships, changes in their skill sets, and changes in or formation of their science identities.

All 51 (17 X 3) interviews were conducted in English and digitally recorded with participant permission. Another student research assistant and I conducted the initial face-to-face interviews in a university office space. I conducted the mid-point interviews over the phone with the exception of 3 students, whom I interviewed face-to-face because they were conducting their research at another local university. All final interviews were conducted by me in a university office space.

In addition to the interview data, I reviewed the students' CVs 6 months after they returned from their SRP to look at their references and as well their completed conference presentations and academic publications to gauge their longer term connections with mentors from the summer.

I also reviewed programmatic data on students applying for travel awards (to present research at conferences) and program evaluation surveys, whereby mentors were asked to rate the quality of their working relationship with their mentees soon after the summer program had ended.

## **2.4 Data Analysis**

Each interview group (three per person) was transcribed and analyzed using NVivo 11 qualitative analysis software. Broad, thematic codes were created based on the content of the interviews and past literature as far as what potentially could serve as social capital for students engaged in these external summer research programs at each of the three points in time. For example, I initially coded 8 sources of social capital, including formal faculty research mentors, post-docs in the lab, graduate students in the lab, undergraduates in the lab, research staff (not faculty), roommates and family. These categories were refined through a cyclical process of categorization and reflection on the data while transcribing and I arrived at 3 final sources of social capital: ‘faculty research mentor’, ‘roommates’ and ‘research teams.’ Upon completion of the initial coding, I conducted matrix queries of the social capital nodes (e.g., faculty research mentors) in order to aid my analysis of similarities and differences between men and women students according to each source of social capital. Psycho-social mentoring, research independence, and concordance were identified as distinct differences between men and women across all of the three sources of social capital. In what follows, I use last names starting with “M” to signify a man mentor and last names starting with “W” to signify a woman mentor.

## **Chapter 3: Results**

Three sources of social capital emerged based on analysis of all interview transcripts. These include: formal faculty research mentors; undergraduate peers that the students live with, called “roommates” in what follows; and research team members, including graduate students, post-docs, research staff, and undergraduates. In what follows I will first discuss these sources of social capital individually. Then, I will present how social capital operates differently and similarly for men and women within undergraduate research training programs.

### **3.1 Formal Faculty Research Mentor**

During the summer research experience, the student’s formal faculty research mentor is the lead professor (usually called the PI by the student) within the research training environment. Once they arrived for their summer research experiences, the majority of students had frequent contact with their mentors: 13 of 17 students reported contact during weekly lab meetings or daily contact with their mentors. Students who reported meeting with their formal faculty research mentors primarily during weekly lab meetings primarily reported gaining professional development skills from these individuals (e.g., connecting students with their colleagues, setting goals for the future, receiving feedback on their research work, and learning how to effectively communicate with professionals in their field). For example, Adrian, an engineering student, who met weekly with his mentor during team meetings, stated, “Talking with my professors, that’s another skill that I’ve obtained. Being able to ask questions and get information, so this will help me get information in the future, so I know what to expect and I am able to make a plan ahead.”

Conversely students who interacted more frequently (e.g., daily) with their formal faculty research mentors in the lab as opposed to just meeting during weekly lab meetings, reported gaining technical and conceptual skills, in addition to professional development skills. Victoria’s

mentor, Dr. Walter, oversaw a small research team and Victoria reported daily face-to-face communication with her mentor. Victoria discussed how their time was spent developing hands-on research skills and learning about networking. Because of the close relationship Victoria and Dr. Walter shared, she was able to discuss her academic and career goals in depth with her. This led Dr. Walter to devise a strategy for how Victoria could network at nearby university that has a particularly strong graduate program in Victoria's area of interest. Victoria explained: "So she told me that I could contact them, that she would help me write emails, and once all the faculty replied to me, then we could arrange to go and visit them. So I could talk to them personally and she would go with me. Like she would take me to [city] and she would stay with me to support me with talking to the faculty and everything." This psychosocial support is significant and valuable for Victoria who is a low-income minority woman in the STEM pipeline. This day trip was a key way in which Victoria was able to build social capital in the form of future graduate school contacts at another university. The time Victoria spent with Dr. Walter was very valuable and unique; most of the students in my sample did not report this level of dedicated time with their mentors that would allow them to build social capital in this way. Their strong connection, and mutual respect for each other, is reflected in Victoria listing Dr. Walter as a reference on her CV and Dr. Walter's rating of her working relationship with Victoria as "excellent" on the program evaluation survey. This is important from a social capital perspective because Victoria is a low-income minority woman in STEM, without this experience and connection with Dr. Walter, she may have missed this opportunity to build social capital for her future endeavors.

Adrian also discussed taking a day trip by car to another city to attend a conference with his mentor, Dr. Wayne. However his experience differed from Victoria's in that his mentor used the time more instrumentally to teach Adrian while they drove. He explained, "instead of putting

on music while we were on our way to [city], she would just play the research papers. There would be like an audio version of them and she would just be explaining and making us analyze things in a different perspective and making... like pushing us to think critically about things.” This time was valuable for technical and conceptual skill gains, although the level of personal closeness established was less than Victoria and Dr. Walter. This dedicated time spent together was valuable for Adrian, but in a different way; instead of focusing on psychosocial mentoring, Dr. Wayne was helping Adrian develop his knowledge and critical thinking skills. Like Victoria, Adrian presented the summer research he conducted and he listed his formal faculty research mentor as a reference on his CV.

After five weeks in their programs, 4 students reported meeting with their mentors less than once per week, which was due to two reasons. The first reason was that the mentors were out of town for the majority of the project; this applied to two students who were assigned to work primarily with graduate students or post-docs in the lab while their mentors were away. The second reason, which applied to the other two students, related antagonism and/or neglect from the mentors. Sofia reported that her mentor seemed uninterested in establishing a relationship with her and did not allow her to work on her own project, instead requiring her to shadow a graduate student. Sofia compared her experience to that of another external undergraduate student visiting the mentor’s lab for the summer: “An individual who’s in marketing, who’s not interested at all, got his own project doing tissue engineering. I try not to speculate on it too much and I believe everything happens for a reason, but I feel like there was something other than my willingness to do the project that kept me from being assigned my own [project].” In this quote, Sofia is alluding to the possibility that discrimination prevented her from being assigned an independent project. Since her mentor was a white immigrant woman (i.e., they shared the same gender), Sofia stated

that she did not feel that it was gender discrimination. I then asked Sofia if she felt that this was related to her race/ethnicity and Sofia responded yes.

In the other case, Alma reported she had reached out to Dr. Wilcox, her assigned PI for the summer experience prior to the experience beginning, but did not receive a response. Because of this, Alma was unaware that her formal faculty research mentor had not received the necessary permissions needed to conduct research until she arrived. This prevented Alma from working on the project, and ultimately with Dr. Wilcox directly. With the support of the program coordinator, Alma was able to conduct research in another lab. Alma ended up being a co-author on a publication and listed replacement faculty research mentors as references on her CV, but she feels somewhat negative about the summer experience due to the initial problem with her mentor.

At the conclusion of their program, 11 students reported plans to stay in contact with their formal faculty research mentors into the future. These students had either asked their formal faculty research mentor for a letter of recommendation or had plans to do so. Michelle was creative in the way she chose to cultivate a relationship with her research mentor before leaving. Michelle told me how she took cues from a networking workshop provided as part of her program in crafting a thank you gift to her research mentor. Michelle stated: “One of our workshops was on mentoring and networking and so basically like the presenter told us like any way that you can stand out, you do it; you do it!” She then talked about how she left a thoughtful gift that he would associate with her, which was a mug from her home institution filled with Mexican candies, along with a personal thank you note. She explained his response to this parting gift: “He sent me an email back saying basically I’m your mentor for life. I’ll be here forever. You know and it was like, oh whoa, he’s so kind, he’s so humble!” Michelle did not report working on a day-to-day basis with her formal faculty research mentor but she was able to implement information given in professional



development workshops to make a meaningful connection with her mentor. Michelle presented on her research after the close of the research experience, and on her CV, not only did Michelle list her primary mentor Dr. Marion, as a reference, but she also listed Dr. Williams, who assisted with the summer program and is also the head of a minority scholarship program at her host institution.

### **3.2 Roommates**

Often students who are participating in external summer research programs are housed in dormitories with other visiting students who are participating in the same program or another program at the same university. 10 students out of the 17 interviewed were housed with their peers and reported socializing regularly with students living close to them who were either students from GROW or from other research programs. The interviewed students often discussed how their roommates were influential in their persistence through the summer by helping them navigate their universities, keeping them socially stimulated outside of their research training environments, and giving them advice and feedback on their research. These students would regularly point out how having the same aspirations was very important in terms of the connections made with their peers in the dorms. For example, when Mariana was asked to reflect on a time where she felt like she belonged during her summer research experience, she discussed the time spent with her peers:

Even though we were different fields, we all had that same purpose in a way for grad school and getting your Ph.D. and you're furthering your education. And that was really... it was just the place where I was most comfortable, with them, talking about it, you know? Maybe because we spent so much time together, but it was just really comforting to be around there, you just fit.

When local and/or returning students also lived in the dorms with the new visiting students, they provided an important bridge to the university and city. Jackie talked about how her roommate, a local student who had participated in the same research program the previous year,

was able to provide valuable information. Furthermore Jackie discussed how her other roommates interacted with and learned from each other, she stated:

My roommate ... has been kind of like our tour guide. She'll tell us where to go, where the good places are to eat or even just about the university. In general, she'll teach us certain things. Even just as we're walking to class, she'll tell us where everything's at. As far as them teaching me things...it's funny because we have a lot of conversations about our research and sometimes we'll get into arguments because it's kind of like an interesting group 'cause there's psychology and one of them is a sociologist and the rest of us are biology. So sometimes we don't always agree on the same things, so we have a lot of conversations. But it's really fun. Yeah, we learn from each other.

This student who Jackie reported living with helped her in all aspects of her research experience by providing navigation around campus, suggestions for things to do outside of the research environment and also feedback and advice that translated into confidence within the research training environment. Students living together can serve as social capital for each other when they provide valuable information, build up each other's confidence, and provide advice that enables them to competently interact with their formal faculty research mentors and other research team members in lab.

Not all students reported being housed with their peers (n=3) or able to establish relationships with their undergraduate peers whom they lived with (n=4). The 3 students who were not housed near their peers participated in research at another university in the same town as their home university and so they lived at home. The other 4 students lived in dormitories close to peers, but they did not build close social relationships. For example, Antonio did not form close bonds with his roommates over the summer, but he compensated by spending time with the graduate student from his lab socially, outside of working hours. When asked if the relationship Antonio had created with the graduate student in the lab was going to be a lasting relationship, Antonio stated:

I feel like it could be useful in the future to connect with [her] and eventually have somebody to work with. I think that it's useful to get insight of their experience in research... like to go to grad school and work with others and their experiences, their bad experiences, their good experiences... how to connect with people, how to go about talking with professors.

Although Antonio did not develop social capital through peer networks, he developed social capital in the form of this graduate student that he believed could aid him in persisting on the path towards graduate school. Luciana also reported being unable to bond with peers in her living space, which prompted her to spend more time in the lab, tapping into different forms of social capital such as her formal faculty research mentor and graduate student mentor. Students who did not report making strong connections with their undergraduate peers often made beneficial trade-offs by becoming close with graduate students within their research training environment.

### **3.3 Research Team Members (Undergrads, Grads, Post-docs, Research Staff)**

During the summer research experience, students worked in different research settings ranging from small laboratories of only 2-3 people to larger research training environments that often worked in partnership with other labs where 10 or more people would be available for students to work with on any given day. The other individuals within the research training environments range from undergraduate students to post-doctoral fellows conducting research. Sometimes, research staff were also present. In what follows I will discuss the differing research team arrangements reported by students and how these different individuals served as sources of social capital.

The majority of students (n=11) reported that graduate students were the individuals they worked with on a daily basis. All students who worked directly with graduate students discussed how they gained technical skills from these interactions. In addition, students reported discussing their future research goals in order to receive advice and guidance. In this way, the graduate

students offered social capital, providing guidance on the process of applying to graduate school as well as introducing mentees to other people and giving mentees guidance on how to make lasting impressions to establish future relationships. They discussed how these graduate student mentors could provide advice such as who to collaborate with, how the process of graduate school works, and the practicality of certain degrees. When Luciana was asked to reflect on how her Ph.D. student mentor contributed to her career goals, she stated:

I told him if I get a Ph.D., I don't know what else I could work in, besides being a PI or a lecturer. He had this class in graduate school where they talk about different careers you could have with a Ph.D. and he told me about what he learned in that class. So he shares a lot of things he learned in graduate school with me. So he's really accessible in that sense.

This graduate student mentor not only provided guidance on the day to day technical skills Luciana needed, but he also opened up new avenues that were previously unknown to Luciana in terms of her future career opportunities.

About half of the students (n=8) reported working with undergraduate students in their summer research environments. These students were generally not labeled as mentors by the students. Most students who reported working with undergraduates in the lab talked about socializing with these students within their research training environments primarily and sometimes asking them for help with understanding different machines around the lab. Interestingly, unlike the peers from the dorms, the students did not form close or lasting relationship with these lab mates. Based on my analysis, they were not sources of social capital in the field of undergraduate research in the same way as their dorm roommates. This is potentially because relationships between the other undergraduate students in the lab had been established during the academic year, before the GROW students began their summer research experiences. This was expressed by Isabel when I asked her if there were any groups of students that she did not connect with, she stated, "Yeah, there's a group of girls at the lab who have been friends for...

they've probably been working in this lab the whole semester, for years probably, and they're very good friends." Their temporary status as summer students, only there for a 10-week time period, seemed to be a common thread when students were asked why they did not bond with other undergraduates present in their labs.

Similar to the close and productive relationships that students formed with graduate students, two out of the four students worked with post-docs in the lab reported creating close relationships that would allow for psycho-social mentoring, outside of learning technical skills and concepts during the 10-week period. Post-docs in the lab were individuals that were available to students and helped them by teaching technical skills and reviewing concepts. They served as social capital by discussing future career goals with the students and helping them to plan their paths toward a STEM degree. Michelle and Elias each reported working directly with a post-doc who became a friend. For example, when I asked Elias to reflect on the best part about his post-doc, he stated, "He became like a best friend to me. It was like talking to another 20 year old." This post-doc served as social capital for Elias by discussing the purpose and benefits of applying to a post-bac program after graduation, something that was unknown to Elias prior to engaging in this summer research experience. Michelle also discussed the emotional support provided to her by the post-doc. In addition to helping her learn the technical skills she needed, this post-doc became someone she could confide in about being lonely due to being away from home. This was an experience that they shared, being that post-doc was an immigrant to the US with her family living overseas.

### **3.4 Gender Findings**

There were several ways in which men's and women's research experiences differed that translated into them accruing different stocks of social capital. These include how they handled

being given research independence, the amount of psychosocial mentoring they received and desired, and the importance of having gender concordance with their mentor and secondary mentors. There were also ways in which men and women were similar, in terms of how they valued the opportunity to gain technical skills, and their relationships with secondary mentors and peers, which I also discuss.

### **3.5 Research Independence**

Key gender differences were uncovered related to how women and men dealt with independence in their research training environments and how their faculty mentors responded to them. Overall, women were less comfortable with being given independence, reported asking many more questions than men, and expressed more self-doubt about their autonomy within their research training environments and the tasks they were required to complete. This is evidenced by Michelle, when she said, “So I would be scared of like blowing up something or messing something up. So sometimes I felt like I was left alone too many times because I don’t know.” Michelle continued to explain how she would reach out to other individuals in the lab for help directly because of these fears. Other women had similar strategies that involved reaching out to their faculty mentors directly. For example Luciana discussed how she handled questions about her assigned tasks: “So whenever I’m not clear about what she wants me to do, I just go up to her before starting, and I ask for approval of what I’m going to do, what I’m going to use and everything.” On the other hand, men expected more independence in the lab and expressed a reluctance to reach out to their formal faculty research mentor when issues or questions arose. Instead, men like Salvador reported trying to resolve issues themselves first and then reaching out for help, if they were unable to resolve their own issue. Salvador explained,

The best part about doing research is, I guess, the independence. Independence because you get to... I mean, my [secondary] mentor was there. I could have asked him anytime, like 'Hey I need help with this.' And I did. But I would try to figure out things by myself and just do the experiments on my own and kind of like get to understand what's going on and how to proceed. Like, what's the next step after I get my results? I think that was the best experience because I got to work independently. Kind of like critical thinking on my experiment.

While Salvador illustrates how empowering he found the independence, some men indicated an awareness that this type of self-reliance may in some cases stem from a lack of confidence in dealing with PIs. Adrian explained that he does not always feel confident when talking to professors and that leads him to struggle in silence. He said: "That's something I was discussing with my PI. I'm not used to asking questions, like to professors. I just tend to go and try to figure it out by myself. So that's the thing I'm trying to change a little. I'm trying to network more with professors and professionals." Marcos illustrated another potential pitfall of too much self-reliance in the lab when he explained, "Sometimes, I start taking longer. I try to figure it out first by myself when I could just ask someone to help me out with that." As exemplified by Michelle, women reported being more more apt to ask questions frequently.

### **3.6 Psychosocial Mentoring**

Women highlighted receiving more psychosocial mentoring from their faculty mentors and from the graduate students on their research teams, who were the team members most often providing social support. For example, when Sofia was asked about the psychological and emotional support she received from her graduate student secondary mentor, she rated him a 10 on a 10 point scale and said:

That's definitely made me feel like I have a lot of support. I do feel like I can come to him with ideas and come to him with propositions like, 'Oh I think maybe we should go in this direction' or 'Maybe I'd like to change this about the thing that I made.' .... I feel like I feel safe enough to propose it and I feel that whatever I say, it will be taken into deep consideration. Like genuine consideration.

Sofia like other women in my sample felt comfortable with her secondary mentor, which allowed her to form a close relationship that could help her in building social capital. Furthermore women often talked about reaching out to their second mentors, if they felt lonely or homesick while away at their host institutions, while the men in my sample did not. As an example, Luciana stated, “So he’s real accessible. And then he tells me a lot about graduate school, he tells me a lot about how he deals with being away from home. ‘Cause I’m in [name of program] and he was also in [name of program] like 2 years ago so he knows what I’m going through.”

Women seemed to desire and seek out psychosocial mentoring from their mentoring relationships more so than men and also just be offered this type of mentoring guidance (without solicitation) because they are women. Men did not seem to be given as much psychosocial support, but they also discussed how they did not need any type of psychological or emotional support. This meant that they were more likely to overlook potential mentors. For example, when Salvador was asked to rate his secondary mentor in terms of psychological and emotional support, he stated: “I would give him a 4. Just because he doesn’t speak up a lot and he doesn’t seem to have authority. So I don’t know if he was like bullied before, like when he was back in [his home country], in elementary school or middle school. He doesn’t have great self-esteem.” Salvador seems to cast aside his secondary mentor in all areas due to his perception that his mentor is not confident in himself. This is significant because secondary mentors can serve as social capital for students, but men exhibited a greater propensity to overlook the potential benefits of establishing these relationships.

Based on student narratives, mentors of women students seemed to engage in more “care work” than did the mentors of men students, which may have influenced how the mentors evaluated the competence and aptitude of their mentees and impacted how women mentees built



social capital. Care work is the emotional labor that often is invisible and performed predominately by women (Acker, 1988). Women often used terms such as ‘patient’ and ‘helpful’ when describing their perceptions of their formal faculty research mentors and their contributions to their overall summer research experience compared to the men in my sample who discussed the social qualities of their various mentors. These terms ‘patient’ and ‘helpful’ are significant when thinking about how femininity is constructed and how women are often expected to perform care work and are more likely to be the recipients of care work. This can be seen by Mariana and how she discussed the best part of working with Dr. Wade’s team: “I think it was their willingness to help, their patience basically. Because especially when it came to the post-docs and the graduate students and in the specific lab, ‘cause they were very patient in teaching us all the techniques and explaining to us how they worked and why they worked the way they worked”. Conversely no men in my sample used the word ‘patient’ when discussing their mentors or research team members, rather men often discussed the social qualities of their mentors and research team members, such as their friendliness. For example Elias used ‘friendly’ to discuss his mentors and talked about the socialization as the best part of the overall summer experience. Elias explained: “Yeah, just trying to make friends and long lasting connections and who you want to connect with. I just focused on that so. I think that’s the best part of traveling too. Meet new people and then staying in contact with them. And yeah I think that was the best part. Also the job, but I think the best part is still the people.” Most of the men in my sample discussed focusing on informal interactions and socializing more so than research, where the women often discussed a focus on learning the techniques and skills needed to produce valid research during their summer experience.

### 3.7 Concordance

Gender concordance between students and their formal faculty research mentors as well as their secondary mentors may influence how students perceive the relationship in addition to the overall stock of social capital arising from the mentoring relationship. In describing the mentees under study and their formal faculty research mentor, 8 women mentees were paired with women mentors while 3 women had men mentors; 2 men were assigned to men mentors and 4 men were assigned to women mentors. While the numbers in each group are small, women seemed to establish strong relationships with women mentors while men paired with women faculty mentors did not make very strong connections. Jackie made statements in regards to her formal faculty research mentor Dr. Willis being a woman in science that demonstrate how symbolically valuable her identity as a woman was to Jackie: “Because she’s a woman with kids and a husband and a lot of people think that’s impossible, right? So I really admire that from her.” Jackie expressed a desire to maintain a connection with her formal faculty research mentor into the future because of the way she conceptualized her as a role model in science. These statements about the marital and parenting status of the mentor were not made by the men in my sample when discussing their formal faculty research mentors or secondary mentors, whether they were men or women. For example, when Adrian was asked why he gave his formal faculty research mentor, who is a woman, a 9 for being a role model, he stated: “So she was the leader and she was the person, like the main person that would direct all of the decisions from the different projects that we were working on and I thought that was very inspiring.” Although this mentor is a mother and wife, Adrian never mentioned these attributes during his interviews, and instead appreciated the traditionally masculine attributes of his mentor, such as leadership, and rated her highly because of this.

Gender concordance may also be an important factor in shaping comfort with informal interactions outside of the research training environment, which lead students to develop social capital. Gender concordance between mentee and mentor led to informal interactions in many cases. The three women who had men as formal faculty research mentors did not report frequent informal interactions outside of the laboratory whereas women with women mentors did. The two men paired with men mentors engaged in informal interactions outside of their research training environments and men overall seemed to want to interact with their formal faculty research mentors and secondary mentors in a more informal socializing way than the women in my sample. Relatedly, some women were also uncomfortable interacting socially with other researchers who were men (apart from their mentors). For example, Jackie discussed how she reached out to a professor she wanted to make a connection with at her host institution, who aligned with her research interests. She explained:

He responded. He said ‘Oh yeah sure anytime we can go... You can ask me questions about what I do over a cup of coffee.’ And when he told me that, I got scared, I was like, ‘no!’ That means I’m gonna have to make a long conversation with him and that’s an opportunity for me to be socially awkward. So I’ve been avoiding that email you know \*laughs\* so yeah I’m not too comfortable doing that stuff.

While we cannot know for sure, it may have been that the lack of gender concordance in this connection that hindered Jackie’s comfort in building social capital with this individual through an informal interaction over coffee.

When Salvador, who was paired with a Dr. Milo as his formal faculty research mentor and secondary mentor who was also a man, was asked if he felt comfortable around people of authority at his host institution, he described a sense of comfort due to an early informal interaction at a bar in his summer experience. He explained, “So I wasn’t expecting that, but it happened and I was happy with it. I was chill with it, like, I didn’t mind, but I wasn’t expecting that, to ever drink with

my mentor. So that was something I wasn't expecting." Even though Salvador may have felt some initial discomfort with going to a bar with this mentor, it did not hold him back from participating in the interaction as was the case for Jackie. Analysis of the students' experiences did not suggest any notable social capital benefits to lacking concordance with one's mentor. Michelle made a strong connection with Dr. Marion, however this was because of their shared status as racial/ethnic minority scientists and she also reported on creating strong connections with her secondary mentors who were women.

As was the case for gender, racial/ethnic minority status concordance between students and their formal faculty research mentors and their secondary mentors also impacted students' relationship formation during their research experiences. An added value seemed to be present when there was gender and racial/ethnic concordance. Daniela, who is the daughter of two Mexican immigrant parents, also discussed connection with her mentor, a woman from South America, over their shared Hispanic heritage. Daniela held the mentor in high esteem because of the challenges she had overcome: "There was a language barrier since her first language was Spanish and so... but now she has many papers and is really successful and has many grants. So I feel like she's a good role model as a woman in science and a minority." Daniela saw her mentor as a role model, which positively shaped Daniela's science identity. It seems as if racial/ethnic minority status alone, even if the individuals involved were from different minority backgrounds, was enough to create a safe space and a bond over shared experiences which could translate into social capital. Michelle, who is Hispanic, explained how her faculty mentor discussed during one of their initial meetings how he could identify with her being a minority within the sciences, being that he is an African American. Additionally Michelle discussed bonding with an African American medical doctor, who headed a scholarship program for minorities in engineering at her

host institution. Because Michelle went to a predominately white institution for the summer, her minority status in her field was often explicitly discussed during her interviews and helped her in building social capital in that predominately white space.

### **3.8 Lack of Gender Differences: Value of Technical Skills, Secondary Mentors and Peers**

While there were several key gender differences, there were also gender similarities which arose when analyzing the data. For example, men and women in the sample both understood the value of the technical and conceptual skills that these research teams were transmitting over the summer experience. Both men and women engaged with their secondary mentors in ways that could provide information and connections to continue onward in their career paths. Moreover there did not seem to be gender differences in men's and women's peer-based social capital. Both men and women reported making connections with students and did not display notably gendered differences in the way they went about building this form of social capital. Men and women both understood the value of having peer networks while they were away at institutions that could provide support and guidance not only on a programmatic level but in terms of personal support. For example, Adrian discussed how conversations about future goals with his peers in the summer program inform his own decisions. He stated, "I think some of the decisions they are planning to make has had an impact on me. Like, 'Oh, that's cool.' 'I didn't know this or I didn't know that.', So they've been a lot of help. We've learned a lot together and we've learned a lot from each other too." Additionally Sofia reported on her plans to stay in contact with another undergraduate lab mate, she indicated:

Like my friend Mike, we both are looking into some of the same medical and Ph.D. schools. We're both interested in some of the same ones. So we're like, 'hey, you know, that's awesome. We might see each other in the future, how cool is that'. And definitely, I think we'll probably keep in touch like during those processes.

Like the majority of the other women and men in my sample, Sofia and Adrian both understand the value of nurturing peer networks that can provide social support during the summer, but also in the future.

## **Chapter 4: Discussion**

In what follows, I will discuss the results from this study as they relate back to the literature on social capital and gender.

### **4.1 Formal Faculty Research Mentors as Social Capital**

Formal faculty research mentors served as the most important source of social capital for students in my sample during the summer research experience by providing them access to social networks that can help them gain entry into graduate programs in the future. Additionally, formal faculty research mentors helped students build their professional development toolkit and scientific identities in order to ensure networking connections are successful. How mentors serve as door openers for graduate school for students and build their professional development field of undergraduate research has been extensively studied in the previous literature (Hurtado et al., 2009; Smith, 2007; Strayhorn, 2010; Thiry and Laursen, 2011; Ovink and Veazy, 2011). Similar to findings presented by Thiry and Laursen (2011), minority students in STEM fields identified their research mentors as individuals instrumental in providing advice and guidance about STEM career paths. Within my sample, successful mentoring relationships created during the summer experience involved mentors being attuned to the psychosocial needs of the student. It is interesting to note that there was gender concordance between most of the students who reported high levels of psychosocial mentoring and daily face to face interactions with their mentors, and most of these strong connections were among pairs of women. These findings show that especially when women are paired with women, mentees can still benefit immensely from this personal contact even during a 10-week period. However, it is important to note that there was not an even split in my sample of men and women students and the numbers of pairs in each of the four concordance groups are small, therefore the importance of gender concordance cannot be definitively determined. These

findings do not support the common assumption that developing strong psychosocial mentoring relationships takes time in order to produce tangible outcomes for mentees such as presenting their research or feeling comfortable listing a reference as a mentor (Thiry, Laursen, and Hunter, 2011; Thiry and Laursen, 2011). Therefore, the high level of psychosocial mentoring received by some students during their relatively short summer experiences is something worth highlighting that contributed to better outcomes for students.

Students in my study who reported having daily face-to-face interactions with their formal faculty research mentor discussed how beneficial this was to them. By spending a lot of time with mentees, it seemed as if mentors were able to transmit not only technical and conceptual skills, but also the norms and expectations of a research career. This professional development helped students during their summer experiences, but students also recognized how these skills can help them in continuing on in the STEM pipeline. Previous research has pointed to the importance of frequent face-to-face interactions to students' overall gains (Thiry and Laursen, 2011; Taraban and Logue, 2012). Similar to previous research (Taraban and Logue, 2012) students who reported frequent face to face contact also reported establishing strong connections with their formal faculty research mentors which then contributed to them listing these mentors as references and presenting on research from their summer experience. Formal faculty research mentors who were frequently interacting with students were rated highly by their mentees in areas such as their academic subject knowledge and their support for setting goals and choosing a career path. These findings point to the significance of mentor quality and frequent interactions in shaping student outcomes, even over short duration programs, which has been shown in a previous quantitative study (Daniels, 2016).

On the other hand, mentoring relationships were hindered when students reported spending little time with their formal faculty research mentor, when he/she was frequently out of town and/or



when he/she relied too heavily on the graduate students and research staff within the training environments to direct mentees' work. Although students within my sample displayed resilience by relying on their secondary mentors, a graduate student is not usually appropriate to be listed as a reference on a CV, or to be called upon for a letter of reference for graduate school. Additionally, a graduate student mentor is unable to authorize a student to present on research done in an formal faculty research mentor's lab. In a few cases, the students sought out mentoring from other faculty members, which was a successful strategy for summer success. It is well-known that frequent face-to-face interaction is part of effective mentoring (Thiry and Laursen, 2011; Taraban and Logue, 2012), and when this does not happen, especially during a relatively short summer experience, students lose out on the potential to accrue social capital from their mentors.

#### **4.2 Roommates as Social Capital**

In this study, students' roommates served as social capital by helping students get through the programs with programmatic knowledge and information in addition to providing social support systems. Students often discussed similar goals and aspirations being a factor that helped them form meaningful bonds with their roommates. Similar to what Hurtado and colleagues (2009) found pertaining to students engaged in summer undergraduate research programs, students in this sample had a competitive drive that was encouraging and motivating, opposed to being discouraging. Interestingly though, students in my sample were not referring to undergraduate peers in their research environments as in Hurtado et al. (2009). Students in my sample rarely reported working with undergraduates in the lab and therefore they were not important sources of social capital in the same way roommates were. Students who live on campus and engage in learning communities have been shown in the previous literature to have better academic outcomes and increased academic engagement than their peers who live off of campus (Trowler, 2010; Pike

& Kuh, 2005; Kuh, 2008). Although this study was conducted during a 10 week summer period, the benefits of housing arrangements discussed by students seemed to mirror those of students who live on campus during the academic year. Housing arrangements that kept students close together contributed to creating social support networks which helped students increase their research self-confidence and scientific identities. Students who reported living together and creating close relationships reported engaging on academic practices with their peers, such as forming peer groups to study for the GRE very early in their undergraduate careers, which may ultimately help them continue on the pipeline towards a STEM degree.

#### **4.3 Research Team Members as Social Capital**

Research team members, including second mentors, also functioned as social capital by being accessible and relatable teachers during summer. Often students reported feeling closer in age and career stage to these individuals and therefore felt more comfortable in accessing information from them in the research training environment compared to their formal faculty research mentors. Research teams cultivated students' research identities and professional development skills by helping students communicate their research during research meetings and helping students feel more confident when interacting with professionals overall. Graduate students were most frequently reported by students as the individuals who served as the second most important source of social capital (after the faculty mentor) by teaching them the technical and conceptual skills, along with providing career guidance and professional development. These graduate students often served as conduits between the students and their formal faculty research mentors by helping students communicate their research during weekly team meetings and by helping students feel more confident when interacting with professionals overall. The literature on research teams suggests that students interact more frequently with graduate students and post-

docs in research training environments compared to faculty (Thiry and Laursen, 2011; Feldman, Dvill, and Rogan-Klve, 2013; Linn et al., 2015; Burgin and Sadler, 2016). Moreover the literature examining undergraduate research training programs and research team dynamics has revealed that members of research teams teach them technical and conceptual skills along with building their research self-efficacy (Dolan and Johnson, 2010). In line with previous research, students in my sample reported learning the technical components of research from these secondary mentors as opposed to being able to build their social capital in the way that they were able to with their faculty mentors. For example, these secondary mentors were able to coach students on what language to use when asking for a letter of recommendation, but they are less powerful as references or writers of letters of recommendation. Overall, functional research team structures and the benefits that students can pull from these teams may point to the quality of the formal faculty research mentor and his/her ability to transmit best practices for mentoring to their secondary mentors, creating environments conducive for students to benefit from even in a short period.

#### **4.4 Research Independence and Gender Differences in Social Capital**

Results from my study suggest that the masculine dominated culture of STEM (Monroe, Ozyurt, Wrigley, and Alexander, 2008; Hurtado et al., 2007) may be rewarding men who perform masculinity in a way that promotes the resolution of research challenges independently before reaching out to their research mentors with greater stocks of social capital. The way in which the men do not ask questions and are more comfortable without much oversight may be working to advantage men in STEM research fields, even though it contributes to worse outcomes in high school (Morris, 2012). My findings suggest that perhaps what works for girls in terms of high school achievement, e.g., asking questions and putting in visible hard work, may not be readily

translating into success within the STEM research team environment, at least in terms of accruing social capital through mentors. Conversely, what has been used as an explanation for boys falling behind girls prior to entering college, a hesitancy to ask questions and instead resolve issues independently, seems to be translating into success within the STEM research team environment. However, it could also be speculated that these strategies for success are dependent on the gender of the students' mentors and the relationships they have established. Perhaps women mentees paired with women mentors are more likely to benefit from asking questions for guidance along the way, whereas women mentees paired with men mentors may be perceived as less competent when compared to their more independent men peers. The gender paradox where women are falling behind men in STEM during college has yet to be explored with this explanation and findings from this study reveal that gender performances may be advantageous for men and an obstacle for women.

The differing approaches to research independence exhibited by men and women students may translate into differences in social capital by the end of their summer research experiences. Within the highly masculine culture of STEM fields, the feminine strategy that compelled women in my sample to ask questions frequently may be read as a sign of incompetence, whereas the men who worked on their research independently and asked questions sparingly, may be interpreted as being more competent and therefore more suited to pursue a STEM degree. These perceptions may lead men students to receive more opportunities and better letters of reference from their mentor, which are social capital in the research field. It is important to note these findings are speculative and demand further study.

#### **4.5 Importance of Gender (and Race) Concordance in Accruing Social Capital**

While the numbers in each concordance category (e.g., men with men) are small, the findings suggest potential patterns that warrant future study. Women students paired with women formal faculty research mentors seems to gain the most in terms of social capital. This gender concordance appeared to contribute to positive outcomes for these pairings, as it was connected to intensive face-to-face mentoring and psychosocial support. Gender concordance with one's mentor may act as a buffer for women mentees against the penalty associated with women mentees' gendered strategies for success which involved asking a lot of questions instead of embracing research independence. Interestingly, gender concordance may help keep women from dropping out of STEM since women formal faculty mentors may not perceive women mentee's gendered strategies as incompetence, but rather they may even reward this type of strategy. Moreover, women students in my sample who identified their formal faculty research mentors as minorities and women in science seemed to place an added value on the relationships they created. Often women in my sample saw their minority women mentors as role models and they expressed how these women were relatable in their experiences in science and how they could see themselves through these mentors. Previous literature on concordance in mentor/mentee relationships has pointed to a consensus that gender/sex concordance is an important component of mentoring relationships whereas the same consensus has yet to be reached with racial/ethnic concordance (Lockwood, 2006; Feeney & Bozeman, 2008; Foley et al., 2006).

Gender concordance has been shown to be important by providing women with role-models in their fields (Lockwood, 2006) and for the psychosocial mentoring benefits for women mentees (Allen, Day, and Lentz, 2005). Results from my study add to the importance of psychosocial mentoring for women mentees and how this type of mentoring with gender

concordance can offset negative perceptions of women's gendered performances. My findings tentatively suggest the benefits of gender concordance between women students and their faculty mentors, where gender concordance did not seem to matter with regards to the women's secondary mentors (e.g., grad students, post-docs, or research staff). Both women (and men) in my sample who lacked gender concordance with these secondary mentors still spoke favorably of these relationships and the benefits they received from them without clear gendered differences. It may be that the perceived similarities in age and career stage narrowed the gap in social status between students and these mentors and therefore lessened the importance of having gender or racial/ethnic concordance.

Gender concordance between women mentors and mentees can provide a particular advantage for women students who perform their gender in a way that may be disadvantageous in a more masculine-dominated setting, which is more common in STEM settings overall. Most women mentees' relationships with their mentors (whether it be their formal faculty research mentor or their secondary mentors) involved psychosocial mentoring that made the quality of the experience better for students. For example, women who ask questions for clarification rather than adopting a 'try and see' strategy may be perceived by mentors who are men as less competent and autonomous when compared to their peers who are men who adopt this type of strategy. Women mentors may understand and relate to their women mentees' strategies differently when compared to women mentees paired with mentors that are men. Previous literature exploring the gender gap between men and women in STEM have explored the "chilly" male-dominated climate of STEM as a factor in Latina students leaving the STEM pipeline (Hurtado et al., 2007). However, when women are paired with women mentors, they may not be perceived as incompetent or unable to independently perform research, if they ask a lot of questions. My findings suggest the hypothesis

that gender concordance between women mentors and mentees may help to counteract the tendency for masculine behaviors in STEM environments to be rewarded, which needs to be examined via future studies involving analysis of data collected from both mentees and mentors.

Men paired with men (primary or secondary) mentors reported more frequent engagement in informal interactions outside the lab and feeling more comfortable interacting in informal settings. Previous literature points out that men are more frequently invited to engage in informal interactions in STEM and in organizations more generally and it is in these spaces that opportunities for advancement and networking are created (Thompson, 2001; Bevan and Learmonth 2013). Some women expressed a hesitance to engage in informal interactions outside of the research training environments, especially with men, which ultimately could be putting men in an advantageous position. The hesitance expressed by women may be due to a lack of gender concordance with potential mentors but also this may have something to do with gender roles more broadly. Unwanted sexual advancements and sexual harassment have been studied in the literature as a reason why women leave STEM (Greenfield and Peters, 2002). Women may not be engaging in informal interactions as frequently or in the same way as their peers who are men, due to fears of romantic advancements or negative judgements about being alone with men outside of the research training environment.

## **Chapter 5: Conclusion**

After summarizing my findings, limitations and practical recommendations will be presented.

### **5.1 Summary**

Formal faculty research mentors served as the most powerful social capital for students as they navigated their summer research experience. Formal faculty research mentors were listed as references on student's CV's in addition to supporting students to present on their summer research projects after the summer experience ended. In this way formal faculty research mentors added to students' professional development and science identities, which may allow them to successfully continue on the path towards a STEM degree. Additionally, students' roommates and research team members served as social capital by building their technical and conceptual knowledge bases. These skill gains translated into research confidence that allowed students to confidently interact with various sources of social capital during their summer research experiences. Students gendered performances contributed to their ability to build and deploy social capital during their summer research experiences. Women in my sample valued spending long hours in their research training environments and asking questions for clarification before embarking on research tasks; they also received more psychosocial mentoring than their peers who were men, which was valuable for them, but may have contributed to them being viewed as novices (and not equal to other team members). Conversely, men valued research independence within the research training environment and engaged in more informal interactions than women. Women's strategizing may serve as a disadvantage when compared to the men's because the men's strategy may be interpreted as research confidence while women are viewed as less confident. Furthermore, men's engagement



in social interactions outside the lab may have opened up doors to establish social capital, and these avenues were much less accessible to women.

## **5.2 Limitations**

Several limitations impacted this study. First, I have limited information on how the mentors viewed the students, since I focused on a student perspective. I was able to augment my data with some survey data on the mentors which asked them to rate their working relationship with their mentee, but all mentors of the students in my sample did not complete the survey. Future research would benefit from conducting brief phone or even email interviews with the formal faculty research mentors in order to gauge their perceptions of student performance during the summer experience. Additionally, most of the mid-point interviews were done over the phone, since the students were out of town, and so the students may have relayed their experiences differently had I been able to complete these interviews in person, as was the case with the initial and final interview. While a strength of the study is the interviews at three points in time, an additional follow-up interview 6-12 months later would be useful in order to see how the students' relationships developed or fizzled after their summer experience. Instead, I relied on reviewing students' updated CV's to see who was listed as the references and who presented their research. Also this study would have benefitted from having an equal number of men and women students. Having an equal number of students of each gender would have given me a richer dataset to work with and would have allowed me to more systematically compare outcomes. Moreover, having a larger sample size would allow for clearer patterns to emerge. This study was also unable to capture a range of gendered performances and therefore should not be interpreted as a one size fits all gender approach. Exceptions to gendered performances exist and future research should flesh out

a full range of gendered performances that could be contributing to accessing social capital in STEM.

### **5.3 Practical Implications**

Programmatic changes to summer research training programs are needed in order to aid in closing the gap between men and women in the STEM pipeline. More program workshops should be offered that relay the importance of building social capital and provide men and women participants with strategies that have been shown to be effective. For example, Michelle discussed how she used an idea from a workshop to create a thoughtful gift for her mentor which helped her create a lasting relationship with her mentors for future opportunities. These workshops can help both men and women mentees understand the value and importance of building social capital and provide them with strategies to do this effectively, even during a short summer experience.

Additionally, undergraduate research training programs can be improved in the future by considering how gender concordance can play a role in advantaging or disadvantaging women in STEM fields and possibly changing matching strategies to improve student experiences. As previous literature has pointed out, there is a consensus that gender concordance is beneficial to women in various fields. It would benefit undergraduate research programs to take this into consideration if they match mentors and mentees. Future studies should examine these relationships and trainings in order to better understand the role gender concordance and racial/ethnic concordance play in advantaging or disadvantaging students building social capital.

Many mentoring training resources are available that can help improve mentoring relationships, specifically mentoring and mentee trainings that help men be better mentors to women. If gender concordance is not a possibility, providing mentors with strategies that improve the quality of mentorship that they provide to women mentees can contribute to student gains from

their participation. Furthermore, by making women mentees aware of information on informal interactions and the benefits of engagement in these outside activities may help women overcome hesitancy in partaking in these interactions with mentors who are men. Men mentees can also stand to benefit from participating in training activities that will prompt them to reflexively think about their women mentors and what they can gain from these relationships.

Table 1: Demographic Information, Research Team Structure, Skill Gains, and Social Capital Outcomes

Pseudonym	College	Classification	Race/Ethnicity	Sex	Parents Income	First Generation College Student*	Structure of the lab and sex of mentors when known (W=Woman M=Man)	Time spent with formal faculty research mentor during summer research experience**	What are students getting from their formal faculty research mentors***	What are students getting from others in the lab**	Did student present summer research at a conference or have a publication under review/published	Did Student list summer research mentor as a reference on CV
Victoria	Physical and Life Sciences	Freshman	Hispanic	F	\$10,000–\$14,999	No	Primary Mentor PI (W) Secondary Mentor PhD Student (W)	High	Prof. Dev. Tech Skills Psychosocial	Tech Skills Psychosocial	Yes	Yes
Alma	Liberal Arts	Freshman	Hispanic	F	\$10,000–\$14,999	No	Primary Mentor Post-Doc (M)	Low	NA: very limited interaction with formal mentor	Prof. Dev. Tech Skills	Yes	Yes
Salvador	Engineering	Sophomore	Hispanic	M	N/K	N/K	Primary Mentor PI (M) Secondary Mentor Graduate Student (M)	Low	Prof. Dev.	Tech Skills	Yes	No
Antonio	Liberal Arts	Freshman	Hispanic	M	\$150,00-\$199,999	No	Primary Mentor PI (W) Secondary Mentor Graduate Student (W)	High	Prof. Dev. Tech Skills	Prof. Dev. Tech Skills Psychosocial	Yes	Yes
Sofia	Physical and Life Sciences	Freshman	Hispanic	F	\$75,000-\$99,999	Yes	Primary Mentor Graduate Student (M)	Low	NA: very limited interaction with formal mentor	Prof. Dev. Tech Skills Psychosocial	Yes	No
Elena	Physical and Life Sciences	Freshman	Hispanic	F	\$100,00-\$149,999	No	Primary Mentor PI (M) Secondary Mentors Research Staff in the research training environment (W)	High	Prof. Dev. Tech Skills	Prof. Dev. Tech Skills	Yes	Yes
Ivan	Physical and Life Sciences	Sophomore	White non-Hispanic	M	N/K	N/K	Primary Mentor PI (M)	Medium	Prof. Dev. Tech Skills	Tech Skills	No	Yes

							Secondary Mentor Graduate Student (M)					
Jasmine	Health Sciences	Freshman	Other	F	\$15,000-\$19,999	No	Primary Mentor PI (M) Secondary Mentor Graduate Student (M)	Medium	Prof. Dev. Tech Skills	N/A	No	No
Luciana	Physical and Life Sciences	Freshman	Hispanic	F	\$75,000-\$99,999	Yes	Primary Mentor PI (W) Secondary Mentor Graduate Student (M)	High	Prof. Dev. Tech Skills Psychosocial	Prof. Dev. Tech Skills Psychosocial	Yes	Yes
Daniela	Physical and Life Sciences	Freshman	Hispanic	F	\$40,000-\$49,999	No	Primary Mentor PI (W) Secondary Mentor Graduate Student (M)	High	Prof. Dev. Tech Skills	Tech Skills	No	No
Isabel	Engineering	Freshman	Hispanic	F	\$30,000-\$39,999	No	Primary Mentor PI (W) Secondary Mentor Graduate Students (W & M)	Medium	Prof. Dev.	Prof. Dev. Tech Skills Psychosocial	No	Yes
Adrian	Engineering	Freshman	Hispanic	M	\$75,000-\$99,999	No	Primary Mentor PI (W) Secondary Mentor Graduate Students (W)	Medium	Prof. Dev.	Prof. Dev. Tech Skills	Yes	Yes
Marcos	Engineering	Freshman	Hispanic	M	\$20,000-\$24,999	No	Primary Mentor PI (M) Secondary Mentor Lab Coordinator (W)	Low	Prof. Dev.	Prof. Dev. Tech Skills	No	No
Michelle	Engineering	Freshman	Hispanic	F	\$50,000-\$59,999	No	Primary Mentor PI (M) Secondary Mentor Post-Doc (W)	Medium	Prof. Dev.	Prof. Dev. Tech Skills Psychosocial	Yes	Yes

Mariana	Physical and Life Sciences	Freshman	Hispanic	F	\$10,000–\$14,999	No	Primary Mentor PI (W) Secondary Mentor Graduate Student (W)	Medium	Prof. Dev	Tech Skills	No	No
Jackie	Physical and Life Sciences	Freshman	Hispanic	F	\$40,000-\$49,999	No	Primary Mentor PI (W) Secondary Mentor Graduate Student (M)	Medium	Tech Skills	Tech Skills	Yes	Yes
Elias	Physical and Life Sciences	Sophomore	Hispanic	M	N/K	N/K	Primary Mentor PI (W) Secondary Mentor Graduate Student (M) Post-Doc (M)	Medium	Prof. Dev	Prof. Dev. Tech Skills Psychosocial	No	Yes

N/K: Not Known

\*First generation college student: Defined as one or both parent having a bachelor's degree or higher

\*\*Time spent: High: Daily face to face interactions in addition to lab meetings and external contact Medium: Some daily interactions, mainly weekly lab meetings Low: Very limited interactions

\*\*\* Prof. Dev. – Professional development skills such as presentation skills, networking skills, and career guidance. Tech Skills – Technical and conceptual skills in the research training environment. Psychosocial – Psychosocial mentoring that involves counseling mentees on issues outside of career and technical skill development

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## **Appendix A: Initial Interview Guide**

Because this interview is part of the GROW evaluation plan, your consent to participate is included in the one consent form that you have signed.

But as a reminder, your information will be kept confidential. We will not use your name in relation to any information that you provide to us. In addition, any specific details that you mention (related to specific faculty members, classes, places, or students) will be masked anytime we use your data. The digital recordings will be kept confidential. At the conclusion of the study, the recordings will be destroyed. You will never be identified by name in any reports, publications, or presentations.

You may ask any questions you have now. If you have questions later, you may contact XX. If you have questions or concerns about your participation as a research subject, please contact the [home institution] Institutional Review Board (IRB)

### **GROW Experiences**

What do you think about your experiences in GROW so far?

Probe: Advising, Peer Mentoring Program, The other students, The faculty who are involved

Have you connected with the other GROW students? Do you have friends in GROW? Why or why not?

What are you most excited about (related to your GROW training sequence) in the coming years?

What are you the most nervous about (related to your GROW training sequence) in the coming years?

How do you feel about [institution under study] (in general)? Probe: classes, extracurricular activities, professors, students

What would enhance your experience?

### **Personal Background**

Talk about yourself as a child.

Where did you live? Did you move a lot?

What was your family like?

What kind of student were you in elementary and middle school?

Did your family face any challenges that you remember vividly? If so, please describe them.

Talk about yourself during high school.

What were your experiences like?

What kind of student were you?

What activities did you participate in?

What were your friends like?

What are you planning to major in at [home institution]?

Why did you pick that major?

How does your family feel about that choice?  
Are there other majors that you are considering? Why or why not?

### **Interest in Science**

What got you interested in science?  
What got you interested in biomedical or health research?  
Why were you interested in applying to GROW?  
    How did you find out about the program?  
    How important was GROW in terms of your decision to attend [home institution]?  
How did you feel when you were accepted to the program?  
    How did your parents respond?  
    Did you tell anyone at your high school? Why or why not?  
Did you have a mentor in high school? Why or why not?  
    If yes, how did they help you?  
Do you currently have a mentor?  
    If yes, how do they help you?  
What do you expect from a mentor?  
    If you have a mentor at [home institution], do you feel your expectations are being met?  
Why or why not?  
How would you describe your ideal mentor?  
What concerns do you have about mentorship?  
You are a successful student, or you would not have been accepted into GROW.  
What do you think inspired you to be successful?

### **Asset Bundles**

(Educational Endowments): Where did you go to high school?  
    What were your high school math and science classes like?  
    How were your teachers in general?  
    Do you feel well-prepared for college-level math and sciences classes?  
    How would you assess your English writing skills? Do you struggle with English? If so, how do you plan to improve?  
(Science Socialization/Identity): Can you picture yourself as a scientist or researcher?  
    Why or why not?  
    Do you see your personality and background as compatible with a science career?  
        Why or why not?  
    Do you identify as a scientist?  
        What does that mean to you? What is a scientist?  
        If not, what would you need to learn or do in order to be a scientist?  
    Have you ever felt excluded or discriminated against as you have participated in science, classes or research? What happened? (Probe: Was it related to gender, race, ethnicity, language, etc?)  
(Network Development): Do you know other people who are researchers or scientists?  
    Do you have a role model who is involved in science or biomedicine?  
        If so, who is this person? How did you meet them? How do they help you?  
(Family Expectations): How does your family feel about you pursuing a research career?  
    Do they have any reservations about it?



Do you think they understand what a research career entails? Why or why not?  
(Material Resources): How concerned are you about making ends meet (that is, money) right now?

Do you contribute financially to your family? If so, in what ways?

Do you take care of/provide for anyone else?

How does this influence your experiences at [home institution]?

Does your family contribute financially toward your education? If so, in what ways?

In terms of your living expenses, do you live at home?

Where do you live? (What part of town?)

What do you pay in monthly expenses?

Do you have your own car?

Is it ever hard to get to [home institution]? If so, please describe.

Did your family face financial difficulties when you were growing up?

What about now?

Are the resources provided to you by GROW useful?

Would you like something different? What?

### **Long Term Goals**

What are your long term goals...

...in terms of your career and profession?

...in terms of your personal life?

Where do you see yourself...

...5 years from now?

...10 years from now?

...20 years from now?

Do you hope to get married? Have children of your own? Why or why not?

Where do you think you'll be living later in your life?

...can you picture yourself living away from [home] ...The US Southwest?

Why or why not?

What might be challenging about leaving? (probe: money, family, etc)

What might be exciting about your leaving?

### **Fear and Challenges**

The idea behind GROW is for you to earn a Ph.D. and become a researcher. How does that make you feel?

What is exciting about that?

What makes you nervous?

What do you think will be most challenging about this path?

Can you picture yourself doing research away from [home] (and your family, if applicable)?

How does this make you feel?

When thinking about the GROW program, how would you assess your stress level?

If not low: What is causing the stress specifically? How is the stress affecting you? What you are doing to address this stress?

Is there anything else you'd like to mention about yourself, your aspirations, or your fears that we did not cover today?

## **Appendix B: Mid-Point Interview Guide**

(NOTE: This interview will be conducted over the phone).

Because this interview is part of GROW's evaluation plan, your consent to participate is included in the one consent form that you have signed.

But as a reminder, your information will be kept confidential. We will not use your name in relation to any information that you provide to us. In addition, any specific details that you mention (related to specific faculty members, classes, places, or students) will be masked anytime we use your data. The digital recordings will be kept confidential. At the conclusion of the study, the recordings will be destroyed. You will never be identified by name in any reports, publications, or presentations.

You may ask any questions you have now. If you have questions later, you may contact XX. If you have questions or concerns about your participation as a research subject, please contact the [home institution] Institutional Review Board (IRB)

Tell me about getting to your university. (How did you get there? How was arriving? How have you been getting around since getting there?)

Tell me about your summer research experience so far.

Tell me about the structure of the lab you are involved in. Do you work with faculty, grad students, post-docs, undergraduates, etc.? What is the predominant gender and race make-up of the people in your lab?

Do you currently have a mentor? (Post-doc, grad student?)

Do you have more than 1 person you consider to be a mentor?

(Repeat these questions if student identifies more than 1 mentor)

Tell me about your mentor.

What kind of communication do you have with your mentor?

How would you rate your mentor in... (after each of the following questions: Why?)

...psychological and emotional support?

...support for setting goals and choosing a career path?

...academic subject knowledge?

...support aimed at advancing your knowledge in your chosen field?

...as a role model?

How often do you communicate with your mentor?

Have they helped you or taught you something new? How do you feel they are helping you? What do you think you learned?

Do you think you will have a lasting relationship with your mentor? Do you plan to stay in contact with this mentor? If yes: how? (email, phone, texting)

What expectations did you have for your mentor when this experience started? Are those expectations being met? Why/why not?

Probes: How is the town? The University? Your living space? What is the gender/race/class makeup of these spaces?

What markers do you use to assess social class?

Have you connected with the other students participating in the program at your school?

Tell me about some of the students you have met so far.

If has made connections with students: How do you connect with these students? Out of the students you've connected with, have they helped you or taught you something? How do they help you? What have they taught you?

Do you think this/these connection(s) will lead to (a) lasting relationship(s)? Do you plan to keep in contact with them? How do you plan to keep in contact?

If hasn't made connections: why do you think you haven't you made connections with other students? Are there groups of students with whom you don't feel as connected to?

Do you feel comfortable calling a professor by their first name instead of Dr. so and so? Why/Why not?

Do you feel comfortable within the (town/community, the university, your living space, your research training environment)?

Tell me about a time when you felt like you did belong.

Tell me about a time when you felt like you didn't belong.

Can you tell me about a problem or dilemma you've encountered during your summer research experience? How did you handle it? Did you reach out to your mentors/peers? Why/Why not?

Back in Fall 20XX when you were interviewed you said \_\_\_\_ about your expectations for the summer research experience. Have your feelings about the experience changed? Why/why not?

Tell me about the best part of this experience so far. Why do you consider this the best part? Were any peers involved in this experience? If yes: How were they involved?

Tell me about the worst part of this experience so far. Why do you consider this the worst part? (Was it related to gender, race, class, language etc.?) Were any peers involved in this experience? If yes: How were they involved?

How do you define a scientist? Back in Fall 20XX you defined a scientist as \_\_\_\_ and \_\_\_\_ about yourself being a scientist. Has this changed? Why/Why not?

Do you identify as a scientist right now? Why/why not? Do you think other students in your program identify as scientists? Why/why not? Does it matter who is asking the question? (Authority vs. peer)

Have you ever felt like you've had to hide a part of your identity with others in the lab, or do you feel comfortable to be yourself? Why/Why not?

Do you feel like you are experiencing or have experienced imposter syndrome? Imposter syndrome is when you feel as though you are going to be exposed as a fraud or when you do not believe you are at the same level as the other people you are working with in your research experience. If yes: Tell me about what happened that made you feel this way.

Do you feel like you are experiencing or have experienced academic intimidation, this is when you feel intimidated within academic settings? If yes: Tell me about what happened that made you feel this way.

Do you feel like you are experiencing or have experienced stereotype threat, this is when you under perform in a situation where you feel as though you might conform to stereotypes (around your gender, your race, your class, etc.)? If yes: Tell me about what happened that made you feel this way.

Tell me about what you have done outside of working in the lab or doing research. Was this with other students from the program?

Do you feel like you were prepared for this summer research program? How were you prepared? (research skills, academic skills, professional interaction skills, leaving home) Why didn't you feel prepared?

Did you find the travel panel with the students and the parents in April useful? Why/Why not? (presentation, student panel, parent panel)

Tell me about skills you think you have learned at this point in the experience. How do you think will these skills be useful to you going forward? Is there something you want to learn that you haven't? If yes: What is your plan to learn these skills?

How would you rate your professional development right now? (language, writing skills, reading skills) Why? What do you think you still need to learn?

How would you rate your ability to successfully complete tasks/succeed in certain situations? Why? What do you think you still need to learn?

How do you feel about presenting a poster with results of your research at the end of this experience?

What are your post-graduation plans at this point? (research career, grad school, etc.?) Do you think this summer experience has helped you clarify your plans? Why/why not?

Have you kept in contact with people back at [home institution] during this experience? How do you keep in contact? Have you had anyone visit you? If yes: Tell me about that visit. If no: Do you have plans to have someone visit before it is over? Who are they?

In terms of finances how concerned are you about making ends meet right now?

How much would you say your monthly expenses are?

Are your parents sending you money?

If yes: how much?

Do you send money back to your parents or family?

If yes: how much?

How does your family feel about you being away while you participate in this research program?

Do you feel like your family understands the work you are doing? Why/why not?

If family doesn't understand: Tell me how you cope with this. (peers, mentors, friends outside the program?)

Is there anything else you'd like to tell me now, about your summer experience?

Thank-you for your time! I'll be contacting you once you return to [home institution], to schedule a final interview to see how everything went.

## Appendix C: Final Interview Guide

(NOTE: This interview will be conducted face-to-face).

Because this interview is part of the GROW evaluation plan, your consent to participate is included in the one consent form that you have signed.

But as a reminder, your information will be kept confidential. We will not use your name in relation to any information that you provide to us. In addition, any specific details that you mention (related to specific faculty members, classes, places, or students) will be masked anytime we use your data. The digital recordings will be kept confidential. At the conclusion of the study, the recordings will be destroyed. You will never be identified by name in any reports, publications, or presentations.

You may ask any questions you have now. If you have questions later, you may contact XX. If you have questions or concerns about your participation as a research subject, please contact the [home institution] Institutional Review Board (IRB).

Tell me about your overall summer research experience.

Probes: What new things did you learn? How does this experience relate to you pursuing a research career?

Have you kept in contact with other students or individuals from your lab? Why/why not?

If has kept in contact: what kind of contact do you have with them? (informal/formal) how do you contact them (texting, emailing, phone calls..?), how often do you contact them? What would be an example of why you would contact them?

Have you kept in contact with your mentor from this experience? Why/why not?

What kind of contact do you have with them? (informal/formal) how do you contact them (texting, emailing, phone calls..?), how often do you contact them? When is the last time you contacted them?

Did you ask your mentor for a letter of recommendation? Why or why not?

During summer you stated \_\_\_\_ about your expectations for your mentor and \_\_\_\_ about these expectations being met. Tell me about how this changed/did not change since we last talked.

Tell me about the best part of the overall summer experience. Why do you consider this the best part? What was the best part of doing research? Being away? The university? The students? The mentors/post-docs/grad students?

Tell me about the hardest part of the summer experience. Why do you consider this the worst part? (Was it related to gender, race, class, language, nativity, etc.?) What was the worst part of doing research? Being away? The university? The students? The mentors/post-docs/grad students?

During your summer experience we discussed identifying as a scientist. Has this changed after this experience? (Increased/decreased) Why/Why not?

After participating in this summer experience, tell me about your thoughts on pursuing a research career. Are they the same? Have your intentions to pursue a research career strengthened or weakened? Why?

How do you think your (race, gender, nativity and English language comfort) shaped your overall experience during summer?

How do you think (the lab, your mentor, your peers, the university) shaped your overall experience during the summer?

Overall did you feel comfortable within the (town/community, the university, your living space, your research training environment)?

Can you talk about a time during the summer when you really felt like you were part of things?

Can you talk about a time over the summer when you felt like you didn't belong?

Can you recall a time over the summer when you felt like you had to hide part of your identity in order to fit in?

Overall do you feel like you were prepared for this summer research experience? How were you prepared? (research skills, academic skills, professional interaction skills, leaving home) Why didn't you feel prepared?

Tell me about skills you think you have learned through participating in this summer program. How do you think will these skills be useful to you going forward?

How would you rate your professional development right now? (language, writing skills, reading skills) Why? What do you think you still need to learn?

How would you rate your ability to successfully complete tasks/succeed in certain situations? Why? What do you think you still need to learn?

Mid-way through summer you said you wanted to \_\_\_\_ after graduating. Now that the experience is over do you still feel the same? Why/why not?

Would you go back and do this experience again?

Same mentor? Why/why not?

Would you consider going to graduate school there? Why/why not?

If you could change different things about this experience what would they be? Why? If no: Why not?

Did you present your research at your host institution? If yes: Tell me about that experience.

How do you feel about the research symposium at [home institution] on September 30<sup>th</sup>? Do you feel prepared? Why/why not?

How does your family feel about the experience?

Do you think your parents views have changed on you pursuing a research career?

Is there anything else that you want to tell me about your summer research experience?

I really appreciate your time in talking with me again about this!



## **Vita**

Heather Daniels was born in Germany but raised in El Paso, Texas. She received a B.A. in Psychology with a minor in Sociology from the University of Texas at El Paso in 2015. For the past 2 and a half years she has been a research assistant at the University of Texas at El Paso. Her research interests include inequality in higher education and STEM education, gender, race, and social class. Heather Daniels will be joining the sociology department at the University of California at Merced in Fall 2017 as a doctoral student.

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