# Social Capital and the Persistence of Students in Science Majors


By

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## SUMMARY

This study is a mixed-methods study examining the impact of social capital on persistence of students in science majors. This study was concerned with whether social capital predicted persistence of students in different science majors as well as non-science majors. Then, this study sought to examine if students in life, physical or other science majors at a Research-I, emerging Hispanic-Serving institution, in a large, urban city, differed on measures that theoretically predict persistence of science majors. This study was also concerned with what social capital, operationalized as institutional supports, were accessed by students in life and physical science majors to persist, and how they negotiated networks in order to maximize benefits and minimize detrimental impacts on persistence.

First a binary probit ridge regression was used to examine if social capital affected 1-yr and 2-yr persistence of students in different science fields, using items from the NELS 88:00 dataset. Two models were used for 1-yr and 2-yr persistence models, one without and one with interaction variables, using 119 covariates for models with no interactions and 149 covariates for models with interactions for a sample of N=5430. An exploratory factor analysis was also used to identify if social capital items measured the same underlying factors as in previous work for the 4-yr college-going sample of the study.

Then a mixed-methods study on a university campus was used to identify any differences between student in different majors on measures that previous literature has indicated or suggested predicted persistence. A survey of N=101 science students on the campus of a university (UNIV) were examined using a ridge regression predicting measures of academic performance, perceptions of campus racial climate, science identity, and measures of peer, family, and faculty social capital.

This was coupled with semi-structured interviews of six students that identified as Latinx and life or physical science students, examining resources that they found as key to persistence, and how networks are negotiated to maximize access to these resources. Interview transcripts were hybrid coded, using evaluation and pattern coding as an approach to reduce the data scope and identify themes associated with accessing institutional supports and the negotiation of networks to do so.

Main findings from the binary probit ridge regression found that social capital predicted a greater amount of variation in persistence for 2-yr than 1-yr persistence models. Yet, baseline differences between majors suggests that students enrolling in particular majors vary before entering higher education, consistent with previous literature.

For the mixed-methods study, an analysis of survey data found that only models for academic performance, peer social capital and family social capital were significant, and these measures did not vary by field. Key institutional supports identified were those that facilitated continuing in higher education, such as financial support, housing, as well as formal supports of academic support and advising. Suggested throughout by participants as key to persistence is an affirmation of their science identity, whether in their conception of performing science, or of their prospective future performance of science. Peer, family, and on-campus networks were negotiated in order to maximize access to resources, but minimize negative interactions, such as being encouraged to leave science, hostility or discrimination from peers, or minimizing social obligations.

# CHAPTER 1- INTRODUCTION AND PROBLEM STATEMENT

This chapter introduces the problem that this study seeks to address- increasing the persistence of students within science majors, with a focus on Latinx[1] students, as they are an increasingly large proportion of the college-going population. This chapter outlines two major reasons for improving persistence, the continued economic advancement of the US, and addressing inequities in outcomes for women and URM students studying science, technology, engineering, and mathematics (STEM). Since the most efficient method for improving the scientific workforces is persistence, these reasons are increasingly converging. A brief outline of why women and traditionally underrepresented minority (URM[2]- Latinx, Black, Native American/First Nations[3]) students persist at rates lower than male and White and Asian students, respectively is also presented. Then, the ability of social capital for addressing issues with the persistence of underrepresented students is presented, followed by the main research questions this study seeks to answer. An outline of this dissertation study is then presented, explaining briefly how each research question associated with the study was to be investigated. This chapter ends with highlighting how this study contributed to the literature on higher education, science education and social capital.

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[1] Latinx is used here to capture the wide array of students captured under the Hispanic identity marker as well as the Latino/a/@/x demographic even though they vary widely in immigrant status, national origin, and racial identity (and often conflates race with ethnicity). White, Black, Asian, American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, Other, More than one race, will be used to be consistent with the demographic markers, although these terms are also problematic due to the diversity within the group markers, and the political roots of race in the US.

[2] Minority is used here instead of minoritized to match the term often used in the literature on inequitable outcomes in education. This study takes the position that minority students have been historically minoritized in ways that aim to disenfranchise groups and emphasize Western conceptions of science and emphasize cultural capital of the dominant class.

[3] Unfortunately, the representation of American Indian/Alaskan Native students in national and many other surveys is too low to have reliable estimates, as is the case with this data. See Shotton, Lowe, & Waterman (2013) for more information on this topic, and the 'asterisk' used to qualify or justify the absence of Native American/First Nations students in research. Unfortunately, this study falls into this critique of normalizing this invisibility of Native American/Alaskan Native students but wishes to at least acknowledge that it does so even though this group shares many of the problems for degree attainment of other minoritized students, often at much higher rates.

The persistence of students in STEM majors in 4-yr undergraduate education remains a concern of policymakers because of the connection of science human capital with the economic fortunes and national defense of the US. Reports released by the National Academy of Sciences (2007, 2010) likened a loss of this human capital and subsequent economic impacts to a category-5 hurricane. This economic impact was feared to lead to a loss of competitiveness for US companies as science and technology job centers shifted to countries with more availability of this labor force (Ibid.). In addition to economic reasons, with cyber-technology increasingly a realm for national conflict, maintaining human capital in computer science is increasingly seen as an imperative of national defense (NAE-NRC, 2012). The importance of STEM education as connected to national and private economic interests is clear and expressed by national organizations like the American Association for the Advancement of Sciences (AAAS) (Olson & Labov, 2008). This is also demonstrated in the current modification of immigration laws, that promote the importation of polices that promote importing high-skilled labor from abroad, while not addressing other immigration policies. This approach inflates number of immigrants as highly-skilled labor, and are used as justification for exclusion of others, including limiting refugees from humanitarian crises (Stevenson, 2014).

Increasing the domestic workforce is seen as a solution to the loss of human capital. There are currently shortages within some science fields, and shortages expected to continue in some STEM fields like computer science and some engineering fields (NAS, 2007, 2010; PCAST, 2012). Increasing persistence of students in STEM is both the most cost-effective and quickest route to addressing this workforce shortage (Graham, Frederick, Byars-Winston, Hunter, & Handelsman, 2013). Additionally, developing a domestic labor force prevents the loss of jobs to other nations. Current polices using immigrant labor to address labor shortages by increasing immigration initiatives have also paved the way for transferring jobs overseas, rather than fulfilling the intended purpose of filling these jobs temporarily until domestic labor could be produced (Salzman, 2013). This suggests that the generation of a domestic workforce is more pressing to address than previously thought if immigrant labor initiatives are increasing the loss of labor, as well as moving job centers overseas.

The investigation of disparate outcomes for URM is relatively new in higher education. Systematic investigation of persistence in higher education generally arose as a field of interest in the 1960's, partly due to the increased influx of diverse students (Berger, Ramirez, & Lyons, 2012). These students varied in SES, gender and racial/ethnic diversity, admitting groups had poorer outcomes than those that had traditionally attended higher education- White, male students. Both from a mix of students using the GI Bill, as well as individuals en masse having new opportunities due to the civil rights movement, the reasons for poorer outcomes among some students emerged as areas of interest.

Interest-convergence has increasingly linked calls for economic progress to equity for underrepresented students in STEM. Achieving equitable persistence outcomes for URM and women students in higher education and STEM is a desired outcome for higher education scholars, but only recently has been associated with meeting the human capital needs of the scientific labor force. This interest convergence of equity and economic advancement has spurred a renewed push to achieve equitable outcomes for students in STEM education (Baber, 2015; Bell, 1980; Delgado, 2001; Matstuda, 1995), without challenging the conditions that created inequitable opportunities for students entering STEM, or for their racialized and gendered experiences in STEM education (Baber, 2015; Zeidler, 2017). This creates a tension where students are valued for their potential to contribute economically to the US, while their lived realities that impede their educative process is unaddressed. Still, persistence in STEM is a problem for all students.

Persistence to graduation (or retention of students by higher education institutions) for all students is generally a problem, with less than 31% of first-time enrollees completing a bachelor's degree in six years, with a greater percentage, (35.5%) leaving with no degree or not currently enrolled in classes (PCAST, 2012). While students that initially enroll in some science fields, most notably life and physical sciences, have higher rates of degree attainment after six years, (56.7% and 57.9% respectively), there appears to be variation between cohorts, as previous studies have indicated fields like physical sciences have low persistence to degree attainment in the field compared to others like life sciences (Seymour & Hewitt, 1997).

Different groups of students have had more positive or negative persistence outcomes. URM students, and other first-generation college students both have lower persistence rates than non-URM and non-first-generation students (Nunez & Cucarro-Alamin, 1998). In STEM fields, women as well as URM students have lower rates of persistence to graduation, even though there have been gains in representation in STEM fields for these groups (NSF, 2014; Riegle-Crumb & King, 2010; Seymour & Hewitt, 1997). Rates of persistence to graduation for White and Asian students are 9% and 16% respectively and are higher than the average rate of 8% across all students, and 4.1% and 4.8% among Black and Latinx students respectively. Still, this fails to explain why rates of female STEM degree attainment (5%) is much lower than male STEM degree attainment (12%- PCAST, 2012).

Latinx and URM persistence is increasingly important to addressing a human capital shortage, with demographics in the US shifting to be more URM. Latinx students are also an increasing proportion of the college-going population, although much of this increase is in 2-yr colleges (Fry & Taylor, 2013; NCES 2018). Women and URM students account for 70% of the higher education student population yet continue to have worse persistence outcomes than their male and non-URM counterparts in STEM, although this varies significantly by science field (Fry & Taylor, 2013; NCES, 2018, NSF, 2016)

The purposes of equity and developing a national workforce are at times at odds with each other. Developing a workforce involves increasing the number of scientists. Polices that import labor rather than address educational inequity allow for the framing of educational inequity as an individual issue and not a structural issue of inequity (Chen & Buell, 2017; Mills, 1997). For example, equity for URM students in STEM is captured in current science education policies, but frames persistence in STEM as an issue of individual student deficits, such as lack of interest or motivation (PCAST, 2012), that rarely addresses the social, cultural, historical influences on persistence in STEM (Holland & Lave, 2001; Malcom & Feder, 2016). This incongruity between developing a workforce and equity for underrepresented groups in STEM is captured in rhetoric of initiatives like Project 2061, that pushed for 'science for all,' as necessary for democratic participation in democratic society, without challenging the inequities that allow for underrepresentation in science. Inequity in opportunities to learn (Oakes, 1990), or that prevents students from being able to act with agency upon their own lives is omitted from this rhetoric (Calabrese Barton, 2002; Bianchini, 2017; Lee & Buxton, 2010), and so equitable STEM education becomes framed as a civil right (Tate, 2001). These views suggest that the underrepresentation of Latinx students in STEM fields is indicative of larger issues of inequality and inequity in US education and developing of a scientifically trained workforce as needing to achieve equity.

This inconsistency means STEM student persistence or attrition from STEM fields is often discussed with little mention of social, political, or cultural implications. Instead, students' pre-college characteristics, such as academic preparation-particularly in math, high school GPA, motivation, and advanced placement science experiences are a focus. This is the case even though STEM students vary less academically within group than when compared with non-STEM students, regardless of demographic backgrounds. Still, this is thought to be an effect of filtering students out of higher education due to inadequate education opportunities to learn science in K-12 education, narrowing the number of URM students that enter postsecondary education (Conchas, 2006; Oakes, 1990; Riegle-Crumb & King, 2010). This also suggests that at the very least, an interplay between college experiences and pre-college factors influence persistence.

Even with this filtering, URM student enrollment and selection of STEM majors is increasing. URM students, particularly URM men, are also increasingly choosing STEM fields, with over 1/3 of Black men and Latinos entering 4-yr STEM programs, compared to about 31% of White men (NSF, 2014; Riegle-Crumb & King, 2010). This increased representation is another reason for examining persistence as these enrollment patterns suggest that interest and motivation to study science is there (PCAST, 2012) although perhaps not captured in interest and motivation surveys, and there are affects in higher education that prevent persistence.

URM students' persistence to graduation rates are lower than for non-URM students. URM students in science leave higher education with no degree at the same rates as leaving with a degree after six years, while White and Asian students, have higher rates of students completing degrees than leaving with no degree, at rates of nearly twice as many. URM students are more likely to attain non-STEM degrees, with eight times as many Latinx and Black students attaining non-STEM degrees than STEM degrees, while five and 2.5 times as many White and Asian students attain non-STEM degrees compared to students attaining STEM degrees (PCAST, 2012). This again suggests that students are having experiences within the university that drive them to other majors.

Persistence and popularity in science fields though varies greatly. Biological sciences majors were the most commonly enrolled by first-time students in STEM (11% of total in 2013), while the physical sciences and mathematics were least popular (2-3% in 2013; Chen, 2013). Current persistence studies rarely account for the differences in students' experiences based on field (Dika & D'amico, 2015), and or rarely examine differences in outcomes based on race/ethnicity or gender in different fields. Since pre-college experiences do affect outcomes, and with different enrollment and persistence to graduation between fields, a deeper analysis of the importance of major on persistence to graduation has been suggested (Griffith, 2010). With little variation between the pre-college academic preparation of students within different science majors, this study hypothesizes that the variation in enrollment is indicative of factors apart from academic preparation described below.

Similar to science field popularity, persistence rates also vary wildly between students in different majors. Life sciences majors have the highest levels of persistence/graduation rates after five years of enrollment (71.4%) while physical sciences, mathematics, and computer sciences majors have the lowest (51.7%) among students who enrolled within STEM fields as their first major (Chen, 2013). When compared to the average persistence/graduation for students across all majors (57.8%), the differences in persistence/retention in STEM fields suggest that life science and physical sciences should be explored as different contexts, with particularities that influence persistence/retention of students within different STEM majors. Other studies indicate that peer and course effects in introductory courses influence student persistence in science majors (NSB, 2012; Ost, 2010), which is important as the first 2 years of post-secondary study are primarily when students leave science majors (Seymour & Hewitt, 1997).

Previous research has identified multiple factors that influence persistence. Underrepresentation can lead to psychological effects impeding persistence, such as stereotype threat, negative self-concept, and domain de-identification (Beasely & Fischer, 2012; Chang, Eagan, Lin, & Hurtado, 2011; Cromley et al., 2013; McGee, 2016; Shapiro & Williams, 2012; Strayhorn, Long, Kitchen, Williams, & Stenz, 2013; Woodcock, Hernandez, Estrada, & Schultz, 2013). URM students must also contend with limited supportive peer environments. They have expressed being targets of discrimination with no coping spaces, or counterspaces, on campus (Cabrera, Watson, & Franklin, 2016; Solórzano, Ceja, & Yosso, 2000; Yosso, Smith, Ceja, & Solórzano, 2009) or a lack of mentorship or guidance from older peers (Newman, 2015; PCAST, 2012; Strayhorn et al., 2013). This is a particular concern for students who may not have the social or cultural capital to navigate through science majors or higher education (Archer, Dawson, DeWitt, Seakins, & Wong, 2015; Yosso, 2005).

URM students also contend with differences in pre-college factors, that explain differences in persistence within students that initially enroll in science majors (Chen, 2013). Yet, URM students, and specifically Latinx students suffer from inequitable K-12 education that influences schooling opportunities and experiences. These include issues like a lack of programmatic opportunities because of segregated or tracked schooling (Conchas, 2006; Contreras & Gandara, 2009; Suarez-Orozco & Suarez-Orozco, 2002; Pew, 2010). This also includes the challenge of integrating into higher education because of a higher likelihood of being first-generation college students, or having to work while attending school more often than students from other racial/ethnic groups (Contreras & Gandara, 2009; Pew, 2010). Interpretation of persistence to graduation rates suggest other issues are at play aside from common pre-college variables.

Researchers have also looked beyond pre-college variables to explain attrition in STEM. This is because the population of students initially enrolling in 4-yr STEM majors, does not vary significantly within this group, when compared to non-STEM majors (Chen, 2013; NACME, 2010). Still, differences within STEM student outcomes suggests some impact from pre-college variables. For example, those students with less math preparation and lower high school GPAs leave STEM majors at higher rates, and are more likely to leave by dropping out, than those with more math preparation and higher GPAs. So, the differing outcomes for URM and female and male student outcomes can partially be explained from inequitable K-12 education and its impacts, but explanations that draw on group or meso and macro level social forces that move away from individual characteristics and experiences of students have been suggested.

Social explanations for the lack of enrollment and ultimately persistence of women in STEM have identified social forces that influence the dispositions and beliefs of students. Dispositions like gendered beliefs associated with STEM vocations (Eccles & Wang, 2015), interest to study science (Steenbergen-Hu & Olszewski-Kubilius, 2017), or self-efficacy in science (Falk et al. 2016), have been shown to influence whether women enter science fields, a case where social structures such as sexism guide the development of individual dispositions. Similarly, women develop stereotypical beliefs related to appropriate vocational pathways (Millet et al, 2015), or are less encouraged to engage in science than boys in the primary and middle grades (Tenenbaum, 2009). This provides some explanation for lower enrollment and graduation of women in STEM fields (Ibid.).

Women studying in STEM fields must also contend with an overall perceived 'chilly' environment in higher education science courses (Cheryan & Plout, 2010; Cromley et al, 2013; Malcom & Feder, 2016; Settles, O'Connor, & Yap, 2016; Seymour & Hewitt, 1997) that can be particularly harmful when experienced from other women in science (Lacrosse et al., 2016). This hostility is also sometimes felt from peer groups (Crosnoe et al., 2008; Robrett, 2015), suggesting peer effects matter for persistence and is seen in other studies (Ost, 2010). Having female math and science teachers in 12$^{th}$ grade, (but not higher education female instructors) (Bottia et al, 2015; Griffith, 2010), expressing a positive science identity (Settles et al., 2016) and positive relationships in science help female students persist in science (Ong, Smith, & Ko, 2018).

URM women must contend with gendered and racialized expectations and discrimination, influencing their persistence, often termed the 'double-bind' for URM women in science, (Malcom, Hall, & Brown, 1975; Ong, Wright, Espinosa, & Orfield, 2011). This suggests that intersectional identity matters in how students respond to social structures of oppression, such as sexism, racism, and classism that act as filters to perceptions of self and belonging in science (Carlone & Johnson, 2007; Chen & Buell, 2017; Collins, 1990). Still, particularly among URM women, experiences of hostility, or alienations occur along similar lines for women and URM students (Chang, Eagan, Lin, & Hurtado, 2011; Johnson, 2007), but with clear instances of gendered discrimination occurring within racial/ethnic groups towards women (Ong et al., 2018).

Common factors related to persistence to degree attainment include race/ethnicity, interest and motivation in science (Steenbergen-Hu & Olszewski-Kubilius, 2017). This raises questions to the effects of pre-college academic variables on the experiences of URM students in

STEM suggests some sort of social impact affecting URM, that may also be affecting interest and motivation in science, ultimately impacting persistence of students. This is thought to be from social or group effects that work to stratify society, as research shows that students' experiences vary by race, gender, SES, and other demographic or other identity markers (Bourdieu, 1986; Stanton-Salazar, 1997, 2001). This has pushed for research to examine the impact of student housing arrangements, culture, campus climate, and peer, staff and faculty interactions mattered for persistence. Foundational to this emerging research was whether students leaving college were doing so because of institutional or individual effects as well as if it they left permanently or temporarily, or not at all but transferred (Tinto, 2012). Individual effects also moved beyond attitudes and dispositions to opportunities, such as funding, proximity to family, change in family situations, or cultural expectations (Braxton, 2001; Oseguera, Locks, & Vega, 2008; Pascarella & Terenzini, 2005; Tinto, 2012).

For persistence in STEM fields for all students, researchers have identified science self-concept (science and math identity) (Perez, Cromley & Kaplan, 2014), sense of belonging, campus climate, academic preparation as measured by test scores and/or Advanced Placement classes and GPA (Chen, 2013; LeBeau, Harwell, Monson, Dupuis, Medhanie, & Post, 2012), parent education and income, and (Chen, 2013; Seymour & Hewitt, 1997), interest in science (Maltese & Tai, 2011), parent education, as pre-college indicators, and college GPA, interest, interaction with faculty (Chittum & Jones, 2017; Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009), and social integration as major factors during college predicting persistence of students in STEM (Chen, 2013). Unfortunately, since most of the research does not disaggregate data comparing students from different racial/ethnic groups within and between different STEM majors based on the above effects, there is a dearth of literature to explain the differential persistence depending on STEM majors for these students. Notable articles that have explored the differences in STEM fields include Chang, Eagan, Lin, & Hurtado (2011) and Gazley, Remich, Naffziger-Hirsch, Keller Campbell, & McGee (2014) in an investigation of biomedical students and Starobin & Lannan (2005) who studied pre-college variables and their effects on choice of STEM major.

Generally, the question of Latinx student persistence has been widely studied, but few have disaggregated data by major and racial/ethnic groupings or gender. Studies of Latinx persistence/retention have identified the role of support that develops a sense of connectedness to campus (Torres, 2006). Studies also point to peer support (Dennis, Phinney, & Chuateco, 2005; Rodriguez, Mira, Myers, Morris, & Cardoza, 2003), campus environment including ethnic spaces (Cerezo & Chang, 2013; Hurtado & Carter, 1997; Hurtado and Ponjuan, 2005; Muniz and Maldonado, 2012), strong familial connections (Hernandez & Lopez, 2005; Perez, 2010), parental education (Arbona & Nora, 2007; Nora, 1987), enrolling full-time (Fry, 2002), and high school math preparation (Crisp & Nora, 2009) as all positive factors affecting persistence. Delayed enrollment and the number of hours worked have been identified as negative factors influencing persistence (Crisp & Nora, 2009).

Theoretical conceptualizations of social capital capture many of these effects as social capital. Social capital generally captures the access to resources that can be mobilized through connections an individual has with others (Bourdieu, 1986; Coleman, 1989; Lin, 2001; Stanton-Salazar, 2011). Ceglie & Settlage (2015) note that effects like family support, peer support, or motivation exist as resources from family and peers to achieve and persist in higher education STEM majors. While disagreement exists in conceptions of social capital, a focus on resources and networks is consistent and provides an avenue for comparison of social capital work.

Additionally, scholars see the connections that individuals have, arranged as networks, having multiple connections that are differently positioned and consequently affording differential access to resources within social networks (Lin, 2001).

Social capital research has shown promise in addressing persistence but has been rarely used to examine the persistence of students in STEM, outside of engineering. Social and cultural capital have been shown to be correlated with persistence in 2-yr and 4-yr institutions (Wells, 2008), and among first-generation students (Duggan, 2002). In science, Ceglie & Settlage (2015) have generally captured many of the positive factors influencing persistence listed in the previous paragraph as being social capital as conceptualized by Lin (1999) and Bourdieu (1986). For them, social capital means resources accessible through networks, but with availability of resources within these networks varying because of status in a socially stratified society. Their findings only highlighted the factors influencing the persistence of their participants and found that academic preparation for college science, faculty support, science experiences in HS and college, family support, science support programs (in higher education institutions), altruistic beliefs (from Carlone & Johnson, 2007), and religion promoted persistence, and resources accessible through family, peer, or school networks.

Engineering has looked to social capital and how it can impact persistence in classes or from year to year. Drawing on Coleman's (1988) and Lin's (1999) conceptualizations of social capital (Brown, Flick, & Williamson, 2005; Brown, Flick, & Fiez, 2009; Dika & Martin, 2017; Martin, Simmons, &Yu, 2013; Simmons & Martin, 2014), these engineering education studies have focused on how resource availability or network structure promote persistence. Very little work has expanded outside of engineering to other fields of STEM, specifically using social capital, but as mentioned earlier, many other studies have examined factors that have been operationalized as social capital (Ceglie & Settlage, 2015).

Bensimon & Dowd (2012) have argued that social capital, conceptualized as institutional supports holds promise improving the persistence of Latinx students in STEM specifically. This conceptualization identifies four types of institutional supports- supports that allow students to counter the stratification that occurs in institutions of society. This conceptualization holds promise for addressing the issues Latinx students in STEM face, if their underrepresentation is due to inequitable resource distribution (Bourdieu, 1973; Stanton-Salazar, 1997, 2001, 2011). Studies have used this conceptualization, capturing the ability of social capital as institutional supports to facilitate the transfer process for Latinx students from 2-yr to 4-yr institutions (Bensimon & Dowd, 2009; Dowd, Pak, Bensimon, 2013), Alternatively, studies have examined how faculty can act to empower students to achieve, operationalized similarly to providing 'opportunities to learn' (Garcia & Ramirez, 2015).

Social capital has also been examined related to persistence in higher education. Some have primarily used quantitative studies to examine persistence of URM and majority students (Soria & Stebleton, 2013; Wells, 2008). Indirectly, the role of social capital on persistence has been examined through intervening variables for persistence, such as academic achievement (Palmer & Gasman, 2008), development of social capital (Museus & Neville, 2012; Rios-Aguilar & Deil-Amen, 2012; Saunders & Cerna, 2004; Yeh, 2010), or peer effects, including attitudes towards a sense of belonging and how it is affected by peers (Sacerdote, 2004; Storia & Stebleton, 2013; Zimmerman, 2003). These variables suggest that social capital at the very least has an indirect effect on persistence.

Science identity is also a construct to understand student's networks, and how they are reinforced or negotiated. Science identity, as a dialectical, developmental construct, captures the agency of students to engage in networks, and in which networks, and for which supports, specifically in science (Varelas, Morales-Doyle, Segura, Mitchener, & Bernal-Munera, 2018; Varelas et al., 2015). While others have not used science identity directly with social capital as an analytical lens or construct, studies have used science identity to explain agency (Carlone & Johnson, 2007; Ibid.; Garibay, 2015, 2017), social position, and positioning (Moore, 2008; Rivera-Maulucci, 2013), making connections with faculty (Chang et al., 2011) and to cope with hostile environments (Settles, 2001; Settles et al., 2016).

Science identity more broadly captures how individuals make sense of seeking institutional supports ad from which networks. In this way, science identity can be used to explain how students are making and determining which institutional agents, or peers, they seek to draw supports from. This also explains how they see science identity and performing of this identity as relating to others within science spaces, framing these spaces as aligned with or conflicting with their science identity (Stets & Burke, 2000; Varelas, 2017). Individuals work to affirm their identity and reposition selves when not aligned with group identity.

To build on past studies quantitative studies that have examined the effect of social capital on persistence (Wells, 2008), this study will seek to narrow this analysis to science majors specifically, and frames the first research question:

- *Does social capital predict 1st and 2nd year persistence for first-time physical science, life science, social science, other-STEM, non-STEM majors in 4-yr undergraduate programs.*

Continuing to build on the literature that has examine the effect of science major on persistence (Dika & D'Amico, 2015), and help explain differences in attrition from science majors this study will compare science majors on measures previously found to influence persistence. Stanton-Salazar's (2001) items for social capital will be used to guide construction of social capital items, as measures specifically constructed to capture a theoretical construct can better capture the phenomenon in question, and a noted measurement issue with using social capital in statistical models (Ream, 2005; Van Neth, 2003). This framed the second research question:

- *Do life and physical science majors in an emerging Hispanic-Serving institution (HSI) differ on measures theorized to impact persistence?*
    - *Do students differ on measures of academic-based social capital, constructed using items from Stanton-Salazar (2001)?*
    - *Do students in life and physical and science majors differ on measures of GPA, science identity, and racial campus climate that are theorized to impact persistence?*

Lastly, in order to build on research that has investigated the experience of Latinx students in higher education, including the promise of social capital to improve the persistence of Latinx students in STEM majors, this study seeks to answer the third research question:

- *What experiences do Latinx students in their $3^{rd}$ year or beyond in life and physical science students identify as central to persist?*
    - *What institutional supports were identified as important for persistence, and who*
    - *did Latinx students draw these from?*
    - *How are students negotiating home and school networks to access resources to persist?*

The first question examines whether or not social capital measures from the NELS 88:00 dataset and used widely in predicting academic achievement (Dika & Singh, 2002; Ream, 2005 similarly predicts persistence for students in different majors through their 1st and 2nd year in 4-year undergraduate programs. An exploratory factor analysis will be employed to explore if items previously identified as social capital indicators (Ream, 2005) align with other measures from higher education that may align. This includes items like frequency of attending church services, participation in sports, or volunteering in the community. A probit ridge regression, using propensity scores as covariates, will be used to examine if students in different majors vary in persistence based on major field. Both science fields and non-science fields are used as it provides another comparison to differentiate between different science fields.

The second research question examines the conceptions of social capital, adapted from Ream (2005) and Stanton Salazar (2001) for the higher education science context, to examine if social capital across fields of science study vary. As noted above, by Ceglie & Settlage (2015), family, peers, and faculty each play a role in promoting persistence for students in STEM majors. Other studies have noted the impact other measures linked with persistence, like racial campus climate, science identity, and academic achievement as measured by GPA (Chang et al., 2011; Hurtado et al., 2011), but only in a subset of students like biomedical students. This study seeks to examine if there exist differences between students in different majors, to help explain the differential attrition from STEM majors. Science identity will also be measured, using operational definitions of Chang et al. (2011), that loosely align dimensions of science identity from Carlone & Johnson (2007). The measures of science identity and science-based social capital will provide a way of guiding the questioning and analysis of data for the final question. Differences between students in different fields will be examined using a ridge regression.

The final question is addressed through semi-structured interviews of six Latinx participants in their 3rd year or beyond of a science major, evenly split between life and physical sciences. Their interviews were transcribed and coded using operational definitions of Stanton-Salazar (2011) for institutional supports and using the lens of science identify (Carlone & Johnson, 2007; Stets & Burke, 2000) to interpret the institutional supports used and from whom they were accessed.

This study contributes to the literature on persistence in higher education in STEM fields by expanding comparison of persistence to include different fields and among the URM group of Latinx students. This study additionally contributes to the work on persistence by accounting for both individual and groups factors, and accounting for the agency that students have, to persist or not as a negotiation of these factors.

This study also contributes to the work on social capital by continuing the use of Stanton-Salazar's (2011) conceptualization among students, like Bensimon & Dowd (2009) to examine the key institutional agents that attribute to facilitating their persistence, specifically among STEM students. Additionally, this study adds conceptions of science identity to social capital to help explain how agency of students is a negotiated process between social forces and aspirations as manifestations of agency (Stets & Burke, 2000).

Lastly, this work builds and expands on identity work in higher education that examines how identity is develops dialectically, in the context of science fields that students study. Science identity or more appropriately, work on identity, is explored in refence to agency of students to access supports. Specifically, this involves examining how science identity explains how students frame their experiences to persist or leave the major. Persistence decisions in the 3rd year of study or beyond, shows how students reframe their trajectories in or out of science as conscious decisions to align their developing conceptions of science identity of the field as aligned or counter to their aspirations for themselves. The next chapter outlines the literature on persistence among URM students and Latinx students in science majors, as the literature on Latinx student persistence in STEM, as opposed to achievement, is still growing.

# CHAPTER 2- REVIEW OF LITERATURE AND THEORETICAL FRAMEWORK

This chapter outlines the literature pertinent to this research study. This review begins by outlining social capital as related to research in persistence in higher education. The section is followed by presenting how STEM persistence literature has emerged from the higher education persistence literature. Then, sources of social supports to persist will be outlined. These differing sources of supports frames the use of social capital to examine persistence, including educational institutions, peers, and family. Then, this is followed by an examination of the literature explaining barriers to these sources of supports. This focus on supports frames the first and second research question, as both will be examining social capital from multiple sources as important to the persistence of students in science majors. An examination of how science identity can help explain how students are negotiating their networks, in order to affirm or counter conceptions of group identity, as well as to mitigate detriments to their views of competence, or performance or recognition in science. Science identity also accounts for how race/ethnicity, gender, or other identity markers by which society is stratified, impact science identity, and will be sued to answer research question three. A theoretical framework based in social capital is then presented as it guides this study.

## Social Capital and Persistence

Social capital, resources accessible through social connections, has been widely explored for predicting academic achievement (Dika & Singh, 2002), and has more recently been used in examining persistence in higher education (Biancani & McFarland, 2013; Musoba & Baez, 2009). This section briefly outlines research that examines the role of social capital on persistence. Then, this section outlines the different sources of supports influencing persistence, but that are not necessarily operationalized as social capital by their authors. This section ends highlighting potential barriers to accessing this social capital

Social capital has shown promise in explaining the persistence of students in higher education. Among 1st generation college students, Duggan (2002), using Putnam's (2001) conceptualization, found that social capital as operationalized as having an email account and being from a home where English was not the 1st language spoken, increased probability of persistence, while delaying entry into post-secondary education decreased persistence. This suggests that modes of communication, are important for 1st-generation students that may lack an established network on which to draw upon to supports. In a broader sample comparing all students in 2-yr and 4-institutions, Wells (2008) similarly found that social and cultural capital, as conceptualized by Coleman (1988) and Bourdieu (1986), positively predicted 1-yr and 2-yr persistence among students. Wells (2008) also found that social capital mattered less for students who began school in 2-yr institutions when compared to those at 4-yr institutions, suggesting that 2-yr institutions may be accounting for social capital differences than 4-yr institutions.

While social capital can influence persistence not all students have access to the same quality of social capital. Using conceptualizations of social capital by Lin (2001), Nichols & Islas (2016) highlighted that students that persisted in their first year, drew different supports from their parents, depending on if their parents had higher education. Those students that had parents with college degrees provided guidance and advice on how to progress, while students who were first generation college students were supported by parents by supports like motivation and encouragement. Additionally, they noted that parents served as the primary support for both groups of students. This meant that 1st generation college students could not receive the level of directly applicable supports as their non-1st generation counterparts received.

In STEM specifically, social capital also promotes persistence. Studies primarily in engineering have shown that accessing peers (Brown, 2005; Martin et al., 2013; Simmons & Martin, 2014), or faculty/staff support (Brown, 2005) for academic support, including TAs (Brown, 2005), and pre-college faculty encouragement (Ceglie & Settlage, 2015) help promote persistence in the major. This is also the case for Latinas and 1st-generation students (Martin et al., 2013; Simmons & Martin, 2014), as students identify staff/faculty/TAs as holding the resources necessary to persist. Similarly, Dika & D'Amico (2015) found peers to be a source of academic support for students in physics, engineering, mathematics, and chemistry (PEMC) majors. Ceglie & Settlage (2015) found that among URM women in STEM majors, structured programs that provided a place to develop networks and connect with peers are important for their persistence. Unlike the above studies Ceglie & Settlage (2015) found that for many, faculty relationships were not important for persistence, because of direct resources like academic supports provided. Instead, recognition and encouragement from faculty were important for students from faculty, as this signaled the potential for these students to persist and served as a fountain of resilience for these students to counter negative experiences later. This suggests that both the source and type of support are important for persistence.

While researchers identified the positive impact of social capital on persistence, there is a noticeable lack of accounting for race/ethnicity, or culture aside from identity markers. Among URM women in science, Ceglie & Settlage (2015) discussed the importance of family and community links as sources of resilience and inspiration to persist, as well as being an anticipated place to provide social capital. This meant entering fields with altruistic ends, such as medicine, and reminders of student's individual reasons for pursuing science majors was part of the support afforded by family in the absence of experience in college or within science majors.

It also meant these altruistic ends also involved indirect motivation to persist. Similarly, Baber et al. (2012) found that Latinx students in STEM, including siblings, peers and community, provide inspiration and encouragement to persist by being within the family structure. Gasiewski, Hurtado, Figueroa, & Garcia (2013) found among a sample of URM scientists that a desire to provide social capital to others is a consequence for students, when they were supported by institutional agents to persist by institutional agents, or individuals within institutions that have access to social capital (Stanton-Salazar, 2011).

**Other Factors Shaping General and STEM Student Persistence**

This section outlines the general research around higher education outcomes of underrepresented students, emerging from higher education research that examined persistence. Then critiques of this research are highlighted as grounding the current examination of persistence of underrepresented students. Issues with the previous examination as to why URM students do not persist will be addressed. Then factors that have been identified are presented along potential source of social capital, as these provide the resources that students use to persist in STEM.

Spady (1971a, 1971b) and Tinto (2012) are often credited with shifting persistence research away from localizing attrition as determined by only student characteristics. Instead, they argued that the higher education institution has a role. This also meant reassessing if student's leaving higher education was a choice, as students have been historically blamed for their departure. As students in the 1960's attended higher education in larger numbers, the diversity increased, and the role of the institution in student attrition was further emphasized, as disproportionate numbers of URM students were leaving higher education Berger, Ramirez, & Lyons, 2012). Tinto's (2012) examination of student attrition suggested that attrition can happen for multiple reasons, both voluntary and involuntary, and he attributed attrition from an institution as coming from individual pre-college characteristics, motivations and aspirations, as well as the socialization into the higher education institution.

Critics raised issues with Tinto's (2012) model for the lack of explicit discussion of gender, race/ethnicity, socioeconomic status (SES), or culture. Other higher education scholars noted how these factors impacted individual characteristics and ability to socialize into academic and nonacademic groups within the university (Braxton, 2000; Braxton & Lien, 2000; Guiffrida, 2006; Tierney 1999). These too, are important in explaining issues influencing the persistence of students in STEM, particularly because of exclusion of students from STEM spaces because of race/ethnicity or gender discrimination (Johnson, 2007). Tinto's work continues to be used, including to examine STEM persistence (Dika & D'Amico, 2015; Ferrare & Lee, 2014), and so these critiques hold for studies that fail to account for how race/ethnicity, gender, SES, etc. facilitate or impede socialization.

A narrower examination of persistence among STEM college majors is not as simple as is the examination of persistence and retention in the institution as a whole. This is because students leaving to new majors are not captured in the Integrated Postsecondary Education Data System (IPEDS) persistence/retention rates reported by institutions of higher education that provide federally-funded financial aid (NCES, 2018). This data is not always easily available outside of institutions and is seldom reported publicly.

This is a concern because of how persistence and attrition is framed. Students initially enrolling in STEM majors are more likely than those that enroll in non-STEM majors to persist to graduation, but not necessarily in their original major (Chen, 2013; PCAST, 2012). This frames attrition from STEM majors into other majors as a choice rather than an outcome from negative experiences in these majors and normalizes a ‘weeding-out’ process (Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012; Malcom & Feder, 2016). With persistence to graduation ~~rates~~ for students initially enrolling as STEM majors at less than 40%, there is a renewed interest in increasing persistence (PCAST, 2012). This is particularly a concern since students that initially enroll in STEM majors have on average, higher academic achievement than their non-STEM counterparts (Chen, 2013).

As the college-going population becomes more URM, and more female (Fry & Lopez, 2012) persistence of students in STEM increasingly becomes an issue of URM and female persistence. The post-secondary student population is increasingly women and URM, now accounting for 70% of the student population, although much of this increased diversity is in 2-yr colleges (Fry & Taylor, 2013; NCES, 2018). The PCAST (2012) report on persistence outlined three ways of increasing URM persistence, by providing experiences including, engaging learning opportunities that promote student achievement, increasing motivation as emphasized by the presence of role models on campus, and by providing experiences that help students identify with STEM through meaningful relationships with faculty and peers in STEM. Of note is the focus on individual and institutional effects, and like Tinto’s (2012) model, fail to explicitly address issues such as race/ethnicity or culture.

Chen & Buell (2017) argue that this focus on student measures, like motivation and academic preparation, reinforces racialized ideologies that certain students should do better because they are more inclined naturally with doing well in STEM. They argue that this reinforces racist ideologies of inferiority among URM students. In addition, this subtly pushes students to disidentify with science as a field and leave, or disidentify from their racial/ethnic identity and persist (McGee, 2016; Woodcock et al., 2012), a similar tension to that expressed by Tierney (1999) for cultural minority students.

Also, the factors raised by PCAST (2012) are interconnected, with achievement in science often improving self-efficacy in science classes (MacPhee, Farro, & Canetto, 2013), and self-efficacy and identification as a scientist improving motivation to persist (Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011). Engaging in authentic science activities that are viewed as relevant to students, when valued as aligned with classroom goals of their teachers, improves persistence as well, and improves development of positive science alignment, increasing persistence (Aikenhead, 2006). Science identity as conceptualized by Carlone and Johnson (2007), involves developing a realized identity, as opposed to a disrupted identity, through the three dimensions of competence, performance, and recognition. This related to persistence as PCAAST (2012) notes the importance of identification with STEM for the persistence of URM students.

The interconnected relationship of these three factors presented by Carlone & Johnson (2007) and how they overlap with those of PCAST (2012) suggests that there may be underlying constructs at play influencing persistence. The inclusion by Carlone & Johnson (2007) of race/ethnicity, gender, or other identity markers also suggests that an examination of persistence of students in STEM must also account for identity, and how identity works for socialization into science networks in STEM majors. For this reason, science identity is used to supplement a social capital framework for persistence and will be discussed in a later section.

**Sources of Supports for Persistence of Students in STEM**

This section outlines the literature on factors influencing student persistence in STEM majors in higher education, particularly among Latinx students where available, and URM students and women when not, as their experiences of alienation in STEM are similar (Johnson, 2007). This section presents the resources used to persist, by sources, as this was highlighted in the last section as important for persistence. Additionally, this helps align the research away from individual dispositions, much as the higher education literature has. As social capital is dependent on social connections, barriers to these sources of social capital will also discussed. resources. This section is organized by outlining the sources of these resources as stemming from: (a) education institutions, or programs within institutions; (b) peer relationships within or outside of school institutions, (c) family, or other groups that insulate students, and (d) barriers to social capital within these sources.

**Education institutions.**

Educational institutions are as source of social capital, as they provide a place where resources that promote persistence are available and accessible. Such resources include providing concrete academic supports, modifying teaching practices/environments that promote engagement and interest, and by working to create open environments for students. As an institution of society, education institutions mirror inequities in society, but are also tasked with addressing this inequity (Apple, 2004; Bowles & Gintis, 2011; Spring, 2016; Stanton-Salazar, 1997). URM students tend to experience inequitable educational preparation and opportunities to learn (Oakes, 1990), and academic supports address this problem while also developing relationships between students and students and faculty/staff. Modifying teaching practices helps to promote interest and engagement among students while also affirming multiple ways for students to practice science. While establishing a positive climate for learning is not encapsulated in Ceglie & Setllage (2015) as social capital, other conceptualizations of social capital do (Stanton-Salazar, 2011).

Educational institutions can foster programs and spaces that offer resources for student academic success. For URM students, institutions that provide programs that promote interest and commitment in science, particularly through programs like undergraduate research, have increased persistence among STEM students (Estrada et al., 2016). The importance of undergraduate research in engaging students in authentic science and connecting students with faculty mentors has been found to help all students, but especially URM students, to persist (Finley & McNair, 2013), particularly among biomedical STEM majors (Barlow & Villarejo, 2004; Hurtado et al., 2009; Hurtado, Cabrera, Lin, Park, & Lopez, 2008; Palmer, Maramba, & Darcy, 2011). Still, there are multiple pressures, such as research, teaching workload, and individual values that play a role in whether faculty chose to offer undergraduate research opportunities (Eagan, Sharkness, Hurtado, Mosqueda, & Chang, 2011). Within or outside of undergraduate research, mentoring and having role models for Latinx students helps them persist in STEM (Camacho & Lord, 2011). This suggests that these experiences are helping develop relationships that students can later use to persist in STEM.

Other programs or spaces that also foster activities that involve practicing science, such as pre-med workshops, have also been found to increase persistence (Palmer, Davis, Moore, & Hilton, 2010; Palmer et al., 2011). Even experiences that do not directly involve practicing science, such as STEM career workshops (Kinkhead, 2003), and science clubs and organizations too, have been found to predict 1-year persistence among biomedical and behavioral science majors (Chang, Cerna, Han, & Saenz, 2008). These experiences provide students with not only ways for engaging in science outside the classroom, but also provide spaces for students to develop networks. The development of both peer networks and connections to faculty that are within science networks can later be used to draw upon resources to persist, but also embed students within these networks.

Still, race/ethnicity, gender, or other identity markers matter for the effectiveness of these interventions. Having a diverse staff appears to be important as some students, such as Black students being taught by Black faculty, as this increases persistence. Yet this is not seen among all populations, as female students are less likely to persist when taught by female faculty, regardless of the race of female students (Price, 2010). Espinosa (2011) also found that working on faculty projects in undergraduate research helps develop science identity among Black and Latinx men but not among Black and Latinx women, suggesting that the positive impacts on persistence may vary by gender. This highlights both the intersectional nature of identity, as well as the importance and salience of identity to relationships and persistence. Still this complicates how structural diversity, the presence of increased diversity at an institution, is not enough to improve student academic performance or persistence for all students, but that there are some groups that do potential benefit from increased diversity, as noted by PCAST (2012).

Other research has suggested that schools can create intercultural programs that help students' socialization into STEM and build networks. Peralta, Caspary, & Boothe (2013) found Latinx students integrate their cultural ways of knowing and funds of knowledge into the study of STEM when given the chance to do so in such programs. This meant that students were incorporating the ways they have experienced science through mediums such as different languages, in ways that affirmed their multiple identities, as they were rewarded and not punished for doing so. This provided students with ways to engage in science in more authentic and engaging ways, as well as highlighting the interdisciplinary ways that science is used, developed and applied. Such examples included a teacher designing a mini-unit with her students in ways that talk about their science practices in dairy farming and help bridge ways of knowing of students with expectations at the university. This process of socialization helps students navigate the differing networks in higher education, while also providing a structure for them to bridge a cultural divide if it exists, between their cultural understandings of science and those of the academy (Stanton-Salazar, 1997, 2011; Tierney, 1999). In addition, this affirmed their identities in ways that did not force students to choose between aspects of their identities (McGee, 2015; Settles, 2004).

Similarly, living-learning communities provide another structure by which institutions integrate students out-of-school and in-school experiences. Living-learning communities can act in ways that address the barriers to accessing social supports while also building self-efficacy, interests, and positive expectations related to STEM majors (Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012). The use of living-learning communities has been shown to reduce disparities between women and men in intent to persist in STEM majors, although this works has not been explored specifically among URM students. Still, this work has also connected these structures with a sense of belonging and community, that other work has connected with increased persistence (Chang et al., 2011; Hurtado et al., 2011).

Living-learning communities also develop sense of belonging, which has been shown to influence persistence. Spanierman, Soble, Mayfield, Neville, Aber, Khuri, & De La Rosa (2013) found that living-learning communities promoted a sense of belonging. This sense of belonging was promoted among URM students of all majors but was only within the living-learning community and not the institution as a whole, highlighting the importance of spaces and places in relation to sense of belonging. Since sense of belonging is congruent to socialization as an inverse measure (Hurtado & Carter, 1994), this suggests that the attrition of STEM majors may be due to a lack of a sense of belonging in STEM majors, but that these students may persist within the institution. This also suggests that living-learning communities act as 'counterspaces,' working to insulate students from negative experiences on campus (Ong et al., 2018), since sense of belonging in living-learning communities did not translate to sense of belonging on campus, and so indirectly promote persistence in STEM.

Additionally, the type of institution matters for resources available from faculty. Griffith (2010) found that the focus and composition of institutions, such as the ratio of undergraduate students compared to graduate students, having no graduate students at all, and a focus on teaching over research all increased persistence of all students, including among URM and female students. Griffith (2010) notes that this in part is because of the pressure on faculty to publish, a particular pressure in research universities that negatively impacts time and ability to connect with students. This suggests that with limited time and varied responsibilities that are not teaching, faculty are limited in both resource availability and ability to engage with students.

Institutional impact on persistence would suggest promise of HSIs interventions to promote persistence. HSIs produce a large proportion of Latinx STEM graduates, with 10 of the top 12 institutions graduating Latinx STEM degree graduates having an HSI designation (Santiago & Soliz, 2012). Still, when compared to Black students at HBCUs, Latinx students at HSIs report lower faculty support from Latinx faculty than Black students at HBCUs, and Latinx students at HSIs did not report more positive faculty support when compared to Latinx students at PWIs, but Black students at HBCUs do (Hurtado, Eagan, Tran, Newman, Changee & Velasco, 2011). In addition, an examination of Latinx STEM students comparing HSI and non-HSI institutions found no difference in persistence between the two groups and found that faculty support and guidance may negatively influence persistence, while undergraduate research positively predicted persistence (Garcia & Hurtado, 2011). The interaction from faculty as negative predictor is most concerning, as previous research has found that this correlates with higher GPA, that predicts persistence (Cole & Espinoza, 2008), suggesting the individual relationship and nature of the research as important to persistence to graduation, but also that there is variation in how students are affected by these experiences.

Other ways that institutions can support students persist is though modification of curriculum as part of teaching practices. Integrating students' ways of knowing science, funds of knowledge, or culture in science can promote interest for students. This can involve expanding curriculum options beyond Eurocentric curriculum (Anderson, 2004), or by integrating students' interests into curriculum to engage students (Aikenhead, 2006; White, Altschuld, & Lee, 2006). These types of changes are also possible among faculty and departments, the level for meaningful change occurs, more so than changes at the institutional level (Kezar, Gehrke, & Elrod, 2015).

Institutions can also foster positive social action within science. Bonous-Hammarth (2000) argues that departmental culture that does not align with student activist goals leads to attrition from STEM majors. Similarly, Carlone and Johnson (2007), and Garibay (2015, 2017) argue that affecting social change is important for URM students in STEM, and STEM departments do not often cultivate social change as a motivator for studying STEM. McGee (2016) has noted that this lack of alignment places students in a position that they reject this aspect of their identity or leave the major. Carlone and Johnson (2007) also mention that this tension can disrupt science trajectories and lead to delayed or an absence of practicing science. Without affirmation of science practices that involve affecting social change, students do not see their science trajectory as realizable, and so engage in other ways to effect change, sometimes outside of science, and be pulled out of science through other networks (Crisp, Nora, & Taggart, 2009).

Similarly, educational institutions can also help students persist by addressing hostile and alienating environments in STEM directly, as these drive students out of STEM. Affirming multiple ways of practicing is one way to accomplish this. Persistence is associated with satisfaction with the academic environment, as an extension of Tinto's (2012) work (Allen & Robbins, 2008). While the 'chilly' environment that drives individual views of meritocracy and ability to succeed in STEM predominate (Malcom & Feder, 2016), scholars also note how damaging racial and gender focused hostility can be for students to persist in STEM majors (Ong et al., 2018). Addressing hostility on campus also increases sense of belonging and by extension persistence in STEM (Chang et al., 2011; Hurtado et al., 2011; Hurtado, Han, Saenz, Espinosa, Cabrera, & Cerna, 2007). Structured programs are one way in which to address this issue (Hurtado et al., 2009). Camacho and Lord (2011) note that hostile climates are often cited by students in HSIs as a reason for leaving STEM, and diversity of faculty can help confront stereotypes of women and URM in STEM, or conversely, can be the sources of discrimination (Johnson, 2007; Strayhorn et al., 2013).

Institutions addressing hostile climate also involves attending to campus racial climate. In addition to the presence of diverse faculty, other ways to address this hostility include working to reduce experiences where racial insults occur, where students are singled out because of their race/ethnicity, or by having their instructors' express stereotypes about racial/ethnic groups, that last of which institutions have the most direct ability to affect (Chang et al., 2011; Strayhorn et al., 2013). Still, this hostility or 'chilly climate' alone is not enough to explain attrition from STEM majors and is only in combination with other effects that it increases URM student's attrition (Chang et al., 2011; Nora & Cabrera, 1996). While this may address the push factors out of STEM, academic performance that is higher outside STEM, net or raw, 'uncurved' grades can draw students out of STEM as well (Ost, 2010; Grandy, 1998; Seymour & Hewitt, 1997). These interventions help move past what Ong et al. (2018) notes institutions do, which is push interventions for 'fixing' deficit in students, rather than addressing the barriers that cause attrition, or produce reform in the department. This approach of fixing deficits, sends a message that racial hostility does not need to be addressed, impacting sense of belonging, and closing of networks for students (Cabrera et al., 2016). This also explains why students sometimes also are pulled away from academic spaces in order to reinforce positive views of identity, and group cohesion (Guiffrida, 2005).

**Peers influencing persistence.**

Peers have a powerful impact on persistence, but like the research on institutions the type of interaction is important in determining whether or not peers positively or negatively influence persistence. Impacts from peers that improve persistence include knowledge and supports to navigate the higher education and science spaces. This includes approaches to dealing with hostile climates and coping with negative experiences by validation of identity, providing motivations, academic support and the development of resistant capital. Peer interactions can also negatively influence persistence by being the source of competitive and discriminatory interactions or are seen as liabilities to persistence. Positive peer interactions are developed in both formal and informal organizations within the campus and can normalize positive interactions and relationships. Barriers to developing positive interactions include experienced discrimination, lack of formal programs or spaces to develop these relationships and the general view of STEM as a competitive environment.

Peer relationships on-campus improve persistence by providing supports to navigate the knowledge to navigate the higher education and science spaces. This includes academic support, but also motivation. Peers provide academic support and collaborating with peers improves persistence (Ost, 2010), particularly when students discuss content with their peers (Hurtado et al., 2007), or if they have high GPAs (Oseguera & Rhee, 2009). This collaboration is especially important for URM students in STEM (Peralta, Maramba, & Dancy, 2011; Strayhorn et al., 2013) and URM women in STEM majors (Espinosa, 2011; Ong et al., 2018), motivating students to persist. These interactions are particularly helpful in developing a sense of belonging in the university, and peer support specifically among Black students has shown to increase sense of belonging, and persistence among all students, not just students in STEM majors (Hausmann, Schofield, & Woods, 2007). This shows that the act of peer support also provides additional benefits outside of the support received, as in promoting a sense of belonging.

Peer interactions on-campus also promote persistence by providing spaces where students can learn to cope with hostility, and find their identity affirmed. Ong et al. (2018) note the many ways that peer relationships help female URM students persist, not only by creating a space to cope with negative experiences, but also to make sense of hostile experiences. This validates URM women identities and successes, and by doing so promoting persistence (Espinosa, 2011). Advice from older peers, both academic and how to socialize into networks, was also valued, and this expands beyond viewing same-race/ethnicity interactions as providing value in socializing into spaces outside of counterspaces. This is how peers help students develop resistant capital, knowledge and skills developed to counter oppressive forces within the university (Peralta et al., 2013).

Peers also provide a space for sharing a common experience to also challenge competitive and individuality climates in STEM through counterspaces. Previous work on counterspaces has focused on racial/ethnic commonalities (Solórzano, Ceja, & Yosso, 2000; Yosso, Smith, Ceja, & Solórzano, 2009) and their ability to insulate peers from hostile climates and create safe spaces away from racialized hostility. Ong et al. (2018) highlight the importance of common experience as bridging racial/ethnic backgrounds for creating supportive peer groups that act to counter the competitive, individualistic environments in STEM spaces. This effectively creates counterspaces from the hostile aspects of science, in addition to the dimensions of discrimination felt in science, gendered and racialized discrimination. Still, this analysis of counterspaces is complicated because of these multiple dimensions, as women express a need to cope with gender discrimination. Both White women and URM women expressed experiencing microagressions directed at women from men of the same race/ethnicity, such as hearing peers espousing stereotypes of racism and male superiority in STEM (MacLachlan, 2006).

Off-campus peer interactions also act to motivate and support students to persist in STEM. These supports are primarily motivation, and like peers on campus, provide a place to discuss hostile experiences to act as counterspaces. Off-campus peers provide a differing motivation, sometimes overlapping with a desire to set a positive model for these peers, and this type of motivation is more often seen as important to persistence among Latinx than White students (Baber, Rincon, & Martinez, 2012). This motivation was most noted by students that were 1$^{st}$ generation to attend college, not only Latinx students, and manifested in a desire to persist in order to be a role model for siblings and peers. This suggests that while Ong et al.

(2018) argue that STEM counterspaces matter for persistence, Baber et al. (2012) suggest that this may have an additive effect to having counterspaces in other places, off or on campus.

Having off-campus supports are also important in the absence of on-campus supports, a problem for URM students in STEM, particular in having same-race/ethnicity peers. URM students by definition are less represented, and so a sense of isolation can form in the absence of same-race peer support, as well as increase pressure to succeed (Strayhorn et al., 2013). This pressure to succeed because of the dearth of URM students in their classes, also promotes deidentification from the field, increasing changes of attrition (Beasley & Fisher, 2012), by raising doubts about whether URM students belong in STEM majors (Strayhorn et al., 2013). Alternatively, peer support among Black students has shown to increase sense of belonging, and persistence, although this was among all students, and not just students in STEM majors (Hausmann, Schofield, & Woods, 2007).

Yet, depending too much on off-campus peers can be detrimental to students' persistence. Students in STEM with higher socialization with off-campus peer networks have a lower sense of belonging on campus, that is associated with lower persistence (Hurtado et al., 2007; Johnson, 2012). Guiffrida (2004) noted that some students (not exclusively in STEM) viewed home peers as liabilities to their persistence in higher education, leading to strategies to negotiate home and on-campus networks in ways that minimize negative impacts. This meant that high achieving students structured a mix of support and severing of relationships who were deemed liabilities from home networks. This suggests that student agency matters in defining network connections among peers.

Similarly, on-campus peers can also be detrimental to students' persistence in STEM. Competitive peer interactions are common in STEM and can reduce persistence to graduation specifically for women, regardless of race/ethnicity (Fischer, 2017). Also, peer interactions that are geared towards social integration over academic reasons can negatively impact GPA, a predictor for persistence in STEM (Cole & Espinoza, 2008). Additionally, Biancani & McFarland (2013) note that students that ask peers about general advice in class do worse academically when compared to students that ask more specific, class-related advice among higher education students. This suggests that the content and nature of the relationship is important for positive effects on persistence.

**Family and persistence.**

Like peers, family act as both supportive and detrimental to persistence. Family act to encourage and motivate students to persist. Family can act much like peers, as an insular network for students studying in hostile environments (Juang, Ittel, Hoferichter & Gallarin, 2016), as well as serve as motivation to persist. Peralta et al. (2013) and Ceglie & Settlage (2015) highlight the important role of family in the persistence of Latinx students in STEM. Most importantly for persistence, family acts a source of encouragement for students. Family also stipulates reasons to persist by providing expectations of success, either as serving as role models for others in the family or because older family members were not afforded the opportunity to attend higher education, or STEM major. In the instances where parents studied science, they can provide an added level of support to their children as they progress through science majors, a particular asset for URM students, and a source of cultural ways of knowing within STEM majors (Archer, Dawson, DeWitt, Seakins, & Wond, 2015; Ceglie & Settlage, 2015)

At the same time, family, as part of home networks, can pull students away from academics for other responsibilities. This is similar to Guiffrida's (2004, 2005) findings that some Black students' home networks were supportive for students that were high achieving, but detrimental or non-existent for those who were low achieving or left higher education. Family obligations, or tragedies were detrimental to students as they were in a place where they had to give support to family rather than receive it. While this sample was not among STEM students, it does suggest students in STEM, or those that transition to other majors, may have also be contending with multiple pressures from home networks. This mirrors findings that show students attrition form STEM majors also occurs when students enter majors that their family want them to study, but with which they have little interest (Seymour & Hewitt, 1997). This also highlights another example of social stratification due to cultural capital of families (Bourdieu, 1977; Stanton-Salazar, 1997), where high achieving students have more supportive environments, than low achieving students that could use the support.

**Sources and barriers to peer networks.**

Sources for student peer networks come from formal programs and structures within the university, informal relationships and organizations, and pre-existing networks. Building these peer relationships, are often central to formal support programs. When established in formal spaces, these supports are normalized. Informal peer interactions, such as in class, or in extracurricular activities also provide a space for student to cultivate positive peer interactions. When students interact with peers in these informal spaces, there is much more variation between students' experiences, ranging from positive to hostile. Pre-existing networks also vary wildly, with some students having connections at a university before attending, to depending entirely on off-campus networks to persist. Barriers to these sources of supports and resources to persist include issues of climate that include competitiveness.

Institutionally supported programs provide resources and spaces for developing networks. Programs that involve tutoring or workshops provide opportunities for the development of networks among participants, as well as normalizing academic, and positive peer interactions. Many programs seek to develop these independent social networks of support for students, apart from the formal programs, and these networks are particularly important for the persistence of URM students (Hurtado et al., 2009; Stolle-McAllister, Domingo, & Carrillo, 2011).

Peer networks are also formed in STEM clubs and organizations. These spaces are more informal spaces compared to formal support programs but organized nearly exclusively with STEM peers and networks. While participation in these more informal programs increases persistence, this is also influenced by experiencing negative racial experiences on campus, with students experiencing the least negative racial experiences benefiting most from the effect clubs and organizations (Chang et al., 2011). Lack of these peer supports are a noted reason for URM students to leave STEM majors (Strayhorn et al., 2013). Informal spaces also provide spaces that are removed from the competitive, chilly climate of science (Malcom & Feder, 2016).

**Science Identity and Networks**

The following section outlines science identity as a way to account for student's positioning within social networks. This section starts by presenting theory on identity, and science identity, and how identity is purposefully and agentically constructed by individuals. Then, theoretical connections between science identity and factors influencing persistence are presented.

Theoretical conceptions of identity in higher education are broad, and come from a variety of fields, such as psychology, and sociology, and are also informed by postmodern and post-structural theories (Torres, Jones & Renn, 2009). Torres et al. (2009) noted that regardless of the conceptions used to discuss identity, there are three common elements to identity, including the: (a) progression/development of identity from simple to complex, (b) dialectical and fluid nature of identity construction, and (c) contextual identity construction leading to different cognitive and behavioral considerations and enactments. Each of these dimensions highlights how identity exists within the nexus of multiple selves, (Holland & Lave, 2001) and within a stratified society (Stanton-Salazar, 2001). Students in higher education STEM majors then are constructing science identities in ways that reflect inequities in society, as well as challenge this positioning, by whether they chose to align with a group identity, or counter it.

Stets & Burke (2000) argue that identity represents roles for each position held within society. The meaning and interpretations of these roles is identity, with identity explaining how individual are nested within groups, or networks. Identity also indicates how individuals within these structures act to purposely reinforce or oppose group membership through validating or 'counter'-ing group identities. This process is also a representation of agency within larger social structures, with agency accounting for individual capacity for decision making, negotiation of position, and aspirations (Stets & Burke, 2003). This means that science identity explains how students are choosing to position themselves in science networks in ways to affirm or counter what they are perceiving as science identity collectively, explaining the instances where students feel the need to position different selves centrally (Settles, 2004), or to suppress aspects of identity (McGee, 2015; Woodcock et al., 2012).

Identity alignment also explains conflicts with institutional culture (like racial campus climate or chilly culture of STEM). Individual sense of belonging, and variations among sociocultural spaces, such as science classrooms are indicative of the depth of socialization into these spaces and based in sociohistorical experiences of individuals and groups (Holland & Lave, 2001; Moore, 2008a, 2008b; Varelas, 2017). This means that alignment with science for racial/ethnic minorities must account for the historical use of science as a tool for racism (Brown

& Mutegi, 2010), with contradictions felt explaining the need to cope for URM students. Agency to position self as aligning with or countering with groups additionally explain why students seek to align with ethnic identities over academic identities, given what alignment with academic identities may mean in highly racialized contexts (Chen & Buell, 2017; Guiffrida, 2005; Solórzano et al., 2000).

Stets, Brenner, Burke, and Serpe's (2017) conception of science identity expresses group membership, boundaries of networks, social position, and agency (Calabrese Barton, 1998; Holland & Lave, 2001; Moore, 2008a, 2008b; Stanton-Salazar, 2011). Stets et al. (2017) note that developing a science identity should translate to persistence as this would theoretically indicate for motivation and engagement in science, that predict persistence (Merolla & Serpe, 2013). A developed science identity would also prevent domain disidentification, as this would not align with science identity, due to the reflection of behaviors reflecting identity expression (Burke & Reitzes, 1981; Stets et al., 2017; Woodcock et al., 2012). This should also allow for preventing the negative impacts of hostile climates expressed as spurring attrition of URM and women from STEM majors.

Science identity is negotiated with other identities, accounting for power and privilege of different identities within different contexts. Johnson (2007), specifically looking at URM women in science, noted how negative interactions with faculty developed a sense of dissonance that alienated them from science. As noted, this is a dialectical process of identity development, with continual deidentification leading to attrition or disrupted identities (Carlone & Johnson, 2007). As noted earlier, this negative perception of racial climate is superseded by other factors, such as parental support, academic achievement, or social integration, but negative experiences with faculty can spur negative effects on academic performance (Beasley & Fischer, 2012), and of social integration (Strayhorn et al., 2013). This is a particular concern among students in STEM, where identification with the field, is racialized, and gendered context that theoretically prevents identification due to race and explains the suppression of racial/ethnic identity among successful URM students in STEM (McGee, 2015). This also suggests that the management of networks is done in ways to insulate students in ways to affirm science identity and persist in STEM.

Lastly, science identity and persistence are related in how aligned the vocational goals are with larger social goals, sometimes competing with the Mertonian ethos of science (Hermanowicz, 2012). This ethos involves a negotiation of science norms as an interplay of what scientists feel they are bounded to do, with what they actually do, by engaging in science networks. This interplay involves reconciling performance of science with perceived limits on practice of science. As Garibay (2015, 2017) and McGee & Bentley (2017) note, URM students have greater measures and desire of affecting social change so limits on science performance that do not align with social agency may prevent the realization of their science identity in the ways they seek to perform, which could lead students to practice science outside of natural sciences or health sciences, and instead enter fields like public health or epidemiology (Carlone & Johnson, 2007). This negotiation of behavior of science identity means assuming roles that align with certain groups or others, and social capital can explain this process. The following section explores how social capital has been used to explain persistence or attrition from STEM majors, as able to capture student and institutional factors influencing persistence.

**Theoretical Framework Integrating Social Capital and Science Identity**

This section will outline conceptualizations of social capital framing this study. This involves operationalizing social capital, explaining how science identity explains network positioning, and for accounting for social stratification. First, multiple conceptualizations of social capital will be outlined. Then, how these conceptualizations help explain persistence will be presented with studies that have used social capital specifically in STEM. Finally, how social capital and science identity explain persistence decision is outlined. Conversely, this also explains difficulty in students identifying with science as a field and pushing students out of science.

Social capital in education has been used to examine impacts on academic achievement, based on social capital, primarily based in the work of Coleman (1988) (Dika & Singh, 2002). Others have used conceptions of social and cultural capital to highlight social stratification (Bourdieu, 1986; Yosso, 2005), focusing on group inequality. Stanton-Salazar (1997, 2001, 2011) drew on conceptualizations of both Coleman and Bourdieu, along with that Lin (1999) to conceptualize social capital as institutional supports. These institutional supports reveal both the institutional agents, and resources as they mobilize resources for others (Stanton-Salazar, 2011)

Stanton-Salazar (2001) used Lin's (1999, 2001) network theory of social capital to synthesize conceptualizations of Coleman (1988) and Bourdieu (1986). The use of Lin (1999) by Stanton-Salazar (2001, 2011) explicitly introduced ideas of: (a) agency, (b) social position and, (c) size and shape of social networks. Individuals within institutions of society that have relatively high-status Stanton-Salazar (2001, 2011) refers to as institutional agents. These institutional agents act to either counter the stratification of society by redistributing unequally distributed resources or reinforce social stratification.

Stanton-Salazar's (2001) synthesis of Coleman (1988), Bourdieu (1986), and Lin's (1999) network theory addresses key concerns of Portes (1998) and Musoba & Baez (2012) as this definition theoretically links individual and group-based conceptualizations of social capital and provides a clear operational definition. Stanton-Salazar (2011) operationalized social capital as four types of institutional supports: (a) direct, (b) integrative, (c) system development, and (d) system linkage/networking support. Direct supports entailed personal resources that can be directly used, or as funds of knowledge, such as understanding of discourses and ways of being, guidance and advice, advocacy, and help in developing networks. These direct supports are directly transmitted from institutional agents to students. Integrative supports entailed guiding students' integration into new networks that provides them resources through participation in those networks. This also involves providing support or guidance into cultural norms and discourses of power of institutions. System development support involves support that indirectly supports students in organizations and activism. This involves institutional agents developing programs that provide other supports for students, lobbying for resources to be channeled to certain students, and advocating for individual students or groups. Lastly, system linkage/networking support involves leveraging networks of institutional agents, by bridging their networks to students, as well as coordinating supports based on identified needs of students, or advocating for student or groups as an intermediary between two or more groups or networks.

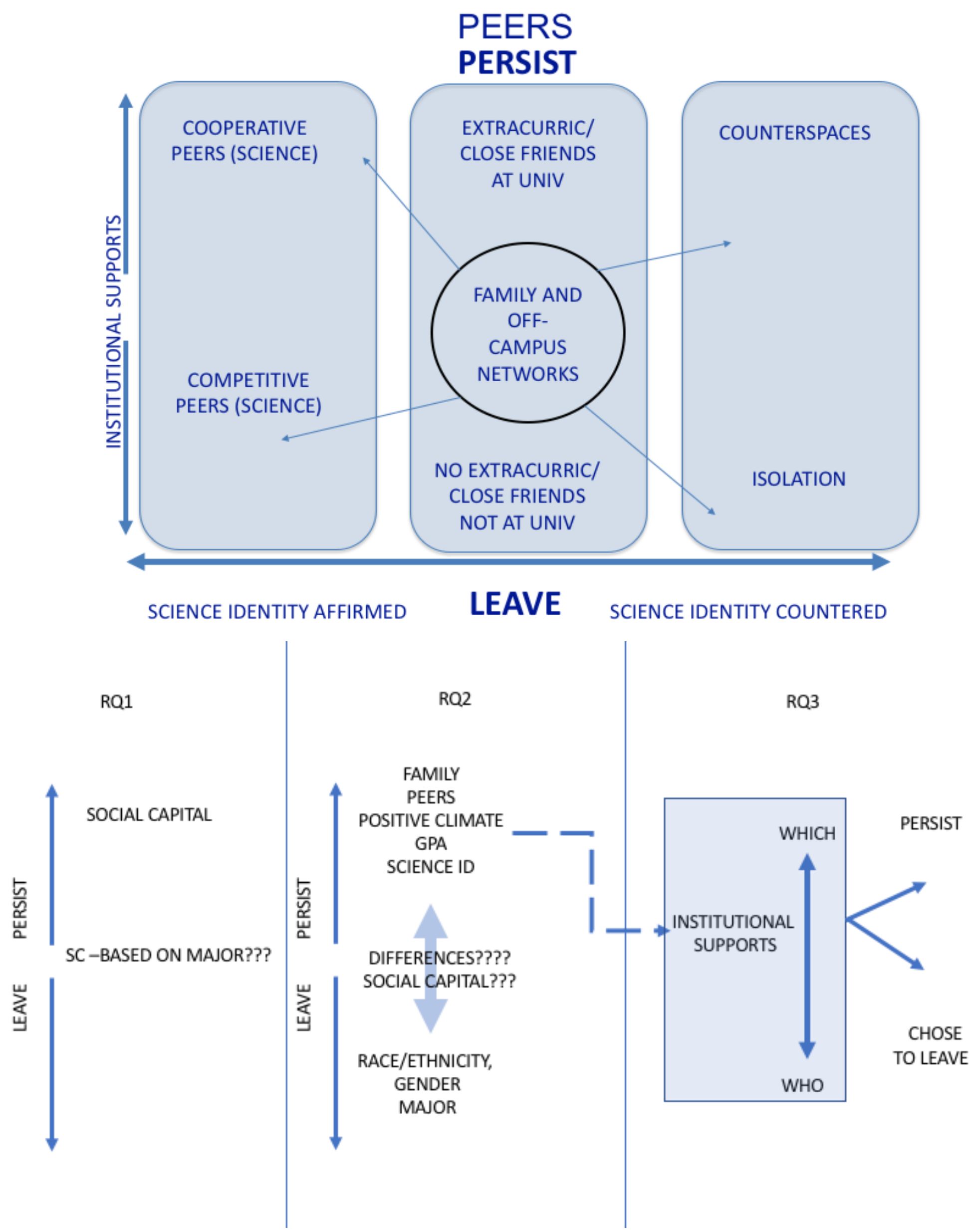
This study similarly uses conceptions of social capital but modifies Stanton-Salazar's (2011) operational definition. This study operationalizes social capital as resources accessible through social connections or networks, that require agency to access or refuse resources. This study moves away from Stanton-Salazar's focus on the institutional agent, to the student that is of relative 'low-status.' This move beyond institutional agents to students captures that this 'low-status' is relative for students in post-secondary education, particularly URM students. As an example, Solorzano, Villalpando, and Oseguera (2005) used Census data from the year 2000 to show the inequity in education for Latinx students, with only about half of the Latinx students starting elementary school, graduating from high school, and not all of those students eligible to attend post-secondary education attend. While-low-status within the higher education institution, they still possess resources of their own they can mobilize, and status within their families or off-campus peers, that they can use to mobilize resources for their benefit.

Others have extended Stanton-Salazar's (2001, 2011) conceptualization of social capital similarly. Stanton-Salazar's (2001, 2011) social capital looks to the institutional agents and the institutional supports provided students in high schools to achieve. Other studies have similarly operationalized social capital, but from the vantage point of the students, as Bensimon & Dowd (2009) do, to highlight the institutional supports students find vital to successfully transferring from 2-yr to 4-yr schools.

Stanton-Salazar (2011) also highlights the importance of practicing identities in order to socialize into networks. While generally drawing on Gee (1989), Stanton-Salazar's (1997, 2001) notes the importance of identity negotiation as important in engaging in 'multiple worlds.' Science identity (Carlone & Johnson, 2007; Stets & Burke, 2001) similarly views identity as dialectical in terms of being and defining, in enactment of self, and aligning with or countering group identity. Like Gee (1989), this framework is conscious of power dynamics within groups. Science identity influences which networks are appropriate to access, such as academic supports or tutoring, but also how students should interact, as in which science practices are considered 'science,' or how scientists should interact with each other in a competitive environment. While Stanton-Salazar (2011) and others (Tinto, 2012) argue that White, middle-class students have aspects of identity that are more aligned with identities that are valued in higher education, others argue that this is instead an affirmation of White, middle-class ideals by academic institutions in order to alienate, pathologize, vilify, and otherwise blame URM groups and students for their lack of success to justify exclusion of URM students from spaces (Chen & Buell, 2017; Haney-Lopez, 2013; Omi & Winant, 1986).

Science identity is also drawn upon as an interpretive lens for explaining the institutional supports students draw upon and which institutional agents students draw from. Science identity explains the roles and positions that students assert. These roles determine the norms and practices along Coleman's (1988) conceptualization of social capital (1988) that students find appropriate. This also identifies positioning of students as within or outside of networks, networks and based on experiences and agency of students as outlines by Stets & Burke (2003). Additionally, Carlone & Johnson (2007) explicitly account for race, gender, etc., and how this impacts views of identity within communities of practice. This means that the positioning and agency also must account for how individuals are conceiving of race, gender, etc., This also argues that positioning must contend with Bourdieu's (1986) and Stanton-Salazar's (2001, 2011) views of social stratification, as well as the agency of individuals, to explain the involvement within science spaces, if at all. With communities of practice theoretically analogous to networks, students engaging in, or not engaging in networks also highlights how they are conceiving of their position and affirmation of self within networks in science majors. Lastly, science identity accounts for individual dispositions and captures the experiences of students before college.

*Figure 1 Visual representation of how factors influence persistence in reference to social capital, Top figure represents peer social capital and the bottom an overview of how social capital answers each research question*



# CHAPTER 3 METHODS

This chapter outlines the methods undertaken in this mixed-method study exploring the persistence of Latinx students in science majors. This chapter begins with the reasoning behind using a mixed-method approach to this study on persistence. Then the research questions are presented with the data sources that were used to answer these questions, summarized in Table I. The first research question is answered using a secondary analysis of NELS 88:00 data, and the dataset is described followed by a description of the items used as variables. A description of the exploratory factor analysis is presented before the binary probit ridge regression models are discussed along with limitations to the dataset and analysis.

Then the on-campus portion of this study is presented, which is used to answer research questions two and three. This section elaborates the survey sample, the design of a survey, the survey analysis approach, and the survey validity concerns. It also elaborates the use of the survey to individualize some portions of a semi-structured interview protocol, a second on-campus data source used to answer the third research question. The third research question is presented along with the semi-structured interview methods used to answer this question. Eligibility criteria for the on-campus student sample used to address research question three are presented followed by a description of the questions in the interview protocol. This section concludes with the data collection and analysis approach including the coding scheme used with the interview transcripts.

## Mixed methods

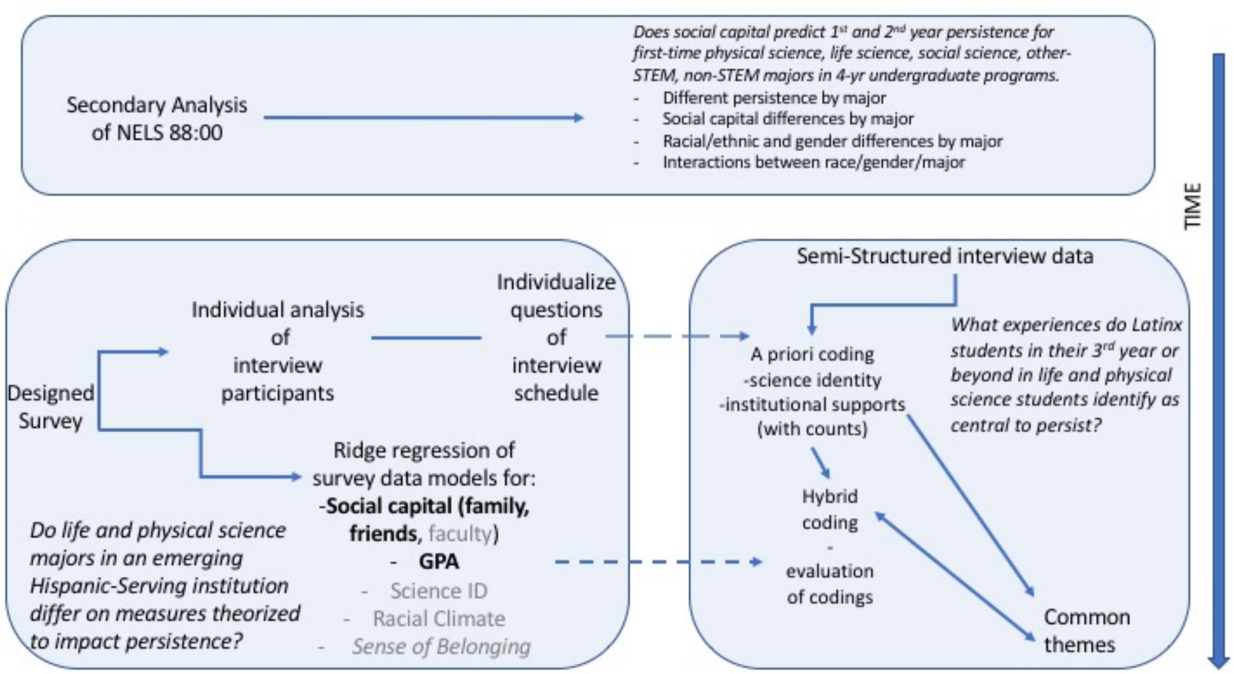
Seeking to learn more about what prevents students from persisting in science majors, this study positions itself using a pragmatic approach to methods. Rather than seek to capture a post-positivistic Truth or interpret what is true through particular perspectives of individuals, pragmatic approaches seek for a shared understanding with a direction to address the problem

*Table I. Research questions and data sources.*

| Research Question | Data source/ Data Analysis | Sample/Setting |
|---|---|---|
| ***1: Does social capital predict 1st and 2nd year persistence for first-time physical science, life science, social science, other-STEM, non-STEM majors in 4-yr undergraduate programs.*** | NELS 88:00/ Exploratory factor analysis-Maximum Likelihood extraction with Promax rotation<br><br>NELS 88:00/ Binary probit ridge regression (1-yr, without and with interactions; 2-yr, without and with interactions) | N=5430, reduced from original NELS 88:00 that had over 14,000 participants. Reduced to students that enrolled as first-time, first-year students in 4-yr institutions and had complete data for follow up surveys in 1992. |
| ***2: Do life and physical science majors in an emerging Hispanic-Serving institution differ on measures theorized to impact persistence?***<br>***Do students differ on measures of academic-based social capital, constructed using items from Stanton-Salazar (2001)?***<br>***Do students in life and physical and science majors differ on measures of GPA, science identity, and racial campus climate that are theorized to impact persistence?*** | Frequencies and descriptive statistics of outcome variables<br><br>Group means for outcome variables<br><br>Ridge regression on designed survey items | N=101/ UNIV students in life, physical or others science majors. Multiple sampling methods, including random email distribution and postings. |
| ***3: What experiences do Latinx students in their 3rd year or beyond in life and physical science students identify as central to persist?***<br>***What institutional supports were identified as important for persistence, and who did Latinx students draw these from?***<br>***How are students negotiating home and school networks to access resources to persist?*** | Semi-structured interviews/ Hybrid coding | N=6/UNIV students that were surveyed, and self-identified as Latinx and a life or physical science major in their 3rd year of study or beyond. |

raised (Morgan, 2007). Morgan (2007) also notes that mixed methods allow for an approach that is not bound to a specific method or paradigm and challenges the paradigm's influence on understanding of a phenomenon. Social capital research on persistence in higher education has drawn upon quantitative, qualitative and mixed approaches (Ceglie & Settlage, 2015; Duggan, 2002; Musoba & Baez, 2009; Soria & Stebleton, 2013; Wells, 2008), and this study builds on this previous work by examining how previous conceptions and more current

*Figure 2. Timing and flow of data analysis.*




conceptions of social capital, both quantitative and qualitative, relate to persistence of students in STEM majors. In the case of this study, a pragmatic approach allows for an understanding of persistence at different scales, both across a broad spectrum of students and experiences, while also looking more deeply at students that have persisted, using both quantitative measures, and student's own conceptions of what mattered for their persistence.

By using quantitative measures of social capital, this study seeks to connect previous social capital research on achievement to persistence and build on the research that has explored persistence as affected by social capital using a large-scale dataset of over 5,000 cases. This allows exploration of a much larger set of data than is usually accessible but is limited by the items surveyed. Still, large datasets allow for broad examinations across populations, often with the intent of generalizing to a population, when representative of the general population (Grimm & Yarnold, 2000). Quantitative measures also provide more objective measures for comparisons among individuals and groups than qualitative data (Hathaway, 1995; Kerlinger & Lee, 2000) In the case of this study, these quantitative measures help tease out the theoretical connections with previous research on academic achievement and provide direction for further exploration in qualitative approaches, or among more narrow contexts.

While a survey method was used for the benefits of objective measures, there are concerns regarding the objectivity of quantitative methods. Multiple studies have highlighted issues in interpretation of survey items (Berends, 2006), and emerging research highlights the lack of positioning described by quantitative researchers. These critics argue that omitting positioning of researchers masks how multiple facets of research are influenced by the researcher. These influences range from approach, to model construction, to interpretation of data (Garcia, Lopez, & Velez, 2018; Gillborn et al., 2018; Motel & Patten, 2012). Combining quantitative methods with qualitative allows for an opportunity to include voices of participants as a check on objectivity of survey tools and provide an expression of agency of participants (Covarrubias et al., 2018), and examine how participants are constructing meaning from their experiences that influence quantitative measures on surveys, or even how they were making sense of survey items (Berends, 2006).

Interview methods, particularly semi-structured or unstructured/open interviews, allow for more voice of the participant to be heard, but unless using direct narrative research, involves meaning making through the researcher as well (Roulston, 2014; Saldana, 2013). This process involves a more nuanced interpretation of a phenomenon. Here, the phenomenon of persistence among Latinx students allows for interpretation of which common supports Latinx students were highlighting as important for their persistence, while having a more objective comparison of these measures as those of social capital.

**Positioning.**

While considered a vital part of some qualitative research methods, there is increasing calls for all researchers to indicate their positioning or positionality, arguing that no research approach can be neutral (Gilborn, Warmington, & Demack, 2018). This advocates identity of the researcher as central to the research study, from framing, design, to analysis. Additionally, this argues the topics studied or claims of objectivity in research both reinforce established epistemologies and ontologies that marginalize many populations, and masks the social influences expressed in research. This section outlines how I position myself within and outside of this research, as both insider and outsider.

My identity as a cis-heterosexual, 2$^{nd}$ generation Mexican immigrant to the US frames how I think about the study Latinx college students, as having some sort of salient connection, or common shared experience as othered in a racialized United States. I also have both biology and chemistry degrees, an experience that frames the comparisons between life and physical science fields. Having been accused of plagiarism and insulted with a slur by a lecturer during my undergraduate studies, both humanities professors, I hold a particular alienation from those spaces and my experience of enjoying anonymity in large science classes as positive and contradictory to other’s experiences. I am closer to family and have a brother who was the first in our US family to graduate with a post-secondary degree, only two years before I did. This positioned me as understanding some of the educational opportunities that my other brother lacked in his schooling. I had little family guidance in my education, and my mother who sought some higher education, and enrolled in two science college classes, failed both and never returned to school. My other brother, who never finished his college degree even though he had a high GPA and has senior standing, struggled with school until college, in part because of the multiple transfers in K-12 education, necessary to receive services for his occupational needs, leaving him alienated and disengaged as he struggled with his dis/ability. I had a father that preferred I work instead of post-secondary education. This framed how I taught, as a former high school science teacher of a population of low-income, primarily Mexican and Mexican-American population. It also framed how I saw their struggles as my struggles, but not my struggles, both similar and different, with their own experiences with education in the US that may not have been as positive as mine. This frames how I am interpreting the tensions that students may be under in their experiences within formal education.

**Research Question One: Secondary Analysis of NELS Dataset**

*Does social capital predict 1st and 2nd year persistence for first-time physical science, life science, social science, other-STEM, non-STEM majors in 4-yr undergraduate programs.*

This section outlines the methods used to answer this research question. First the sample and dataset used to answer this question is presented. Then, the approach to the exploratory factor analysis used described. While factor analysis is frequently used to reduce the number of variables in models, items will not be removed from models exploring persistence as ridge regression corrects for multicollinearity that can arise from multiple complimentary measures. A probit ridge regression will be described as this model was used to examine the effect of social capital among students in different majors on 1-yr and 2-yr persistence. Additional predictors of college major, racial/ethnic identification and gender are also included in this model to identity if these measures affect persistence. Lastly, validity concerns will be discussed.

**NELS 88:00 sample and narrowed study sample.**

This section outlines the sample for the NELS 88:00 dataset. This NELS baseline survey of 1988 survey administered surveys to students, parents, administrators, teachers and test data of a nationally representative sample of students in 8th grade, with a total of 24,599 student participants in this baseline year. Follow up surveys in their sought to survey students and parents two and four years later in 1999 and 1992, for high school data outcomes, and six and 12 years beyond the baseline years in 1994 and 2000. Of the 24,599 students from the baseline survey, 12,144 students participated in follow-up survey data, that included post-secondary education transcripts and outcomes.

This dataset was narrowed for this analysis. From the original N= 24,599, the sample for study was reduced to an N=5435. This reduction in cases was done by narrowing the dataset to cases where participants attended a 4-year postsecondary institution directly after high school and was confirmed by the number of postsecondary institutions attended being greater than 0. Additional reductions were made from this list for any observations where initial enrollment major, major after 1 year, and major after 2 years, were missing data, as this data was used to calculate persistence in the same major after 1 or 2 years and should not be inputted if missing. Additionally, cases with missing data for more than 30% of variables were also eliminated, and hot deck imputation used to impute for other missing data. Variables with greater than 40% missing data were also removed. While it is often inadvisable to remove variables as missing data elucidates patterns as well, given the nature of the dataset as a compilation across three timepoints, these patterns would be unclear if considered across the dataset.

**NELS 88:00 dataset.**

The NELS dataset is a cross-sectional, longitudinal, nationally representative survey of 8$^{th}$ graders during the 1988 initial survey year, with follow-up surveys during the years 1990, 1992, 1994, 2000. The NELS 88:00 dataset subset of the NELS dataset contains data of 12,144 cases including postsecondary education enrollment and persistence data, approximately 8 years after graduation high school (F4- approximately 8 years after high school). This data was merged with earlier dataset surveys in 1992 (F2- approximately 12$^{th}$ grade of high school), and 1994 (F3- approximately 2 years post-high school). In addition to student data in the F2 dataset, F2 also contains responses from parent surveys.

The dataset contains data from multiple sources, including surveys of students, parents, administrators, and teachers at multiple timepoints. Additionally, transcripts and exam data supplemented this dataset. The content of the surveys included items on student background, language usage, home environment, perception of self, occupational plans, jobs and household chores, school experiences and activities, and work and social activities (Curtin et al., 2002). Later surveys introduced items on post-secondary access, and experiences and outcomes, including transcripts. As previous research has used items from the NELS dataset to predict academic achievement (Dika & Singh, 2002; Ream, 2005), and persistence (Wells, 2008), items were selected using these studies as guidance, particularly that of Ream (2005). Full listing of items used from Ream (2005) are listed in Appendix A, and a description of items will be given in the next section.

***Variables.***

This study identified variables that have previously been theoretically and empirically tested to be proxy measures for social capital (Ream, 2005). This study drew on these social capital items used by Ream (2005) from the NELS dataset, as a foundation for the social capital predictors of persistence. As all these items were from the NELS 88:92 dataset that included baseline and F2 items, this study supplemented items from the 1994 (F3) and 2000 (F4) surveys that theoretically aligned with those used by Ream (2005). Additionally, items theoretically measuring negative social capital were also added (Portes, 1998), as well as items previously identified in the literature as impacting persistence. These items were measuring for educational expectations, demographics, and higher education status (PCAST, 2012). Table II provides examples of these items, and a full listing is provided in Appendix A. Factor analysis was then used to see if these measures measured common factors of an underlying construct of social capital, or multiple factors, as theorized by Ream (2005).

*TABLE II. Example items for variable groups in NELS dataset.*

| **Variable Category** | **Example item** |
|---|---|
| **Social Capital -1a-Parent/student involvement in education** | Student chose school/academic program with parents |
| **Social Capital -1b-Parent/Student bond** | Parent attended family social functions with teen |
| **Social Capital - 1c-intergenerational closure** | Student's parents know closest friend's parents |
| **Social Capital - 1d- Parent involvement in school activities** | Parent attends school activities with teen |
| **Social Capital – 2-Students connections w/peers** | Student does things with friends |
| **Social Capital – 2c-Student's peers prioritize academics** | Student's friends think it's important to study |
| **Social Capital - 2-Other peer social capital** | Volunteer providing services to other students |
| **Social Capital - 3a-Student/parent participation in community** | Student volunteers in community |
| **Social Capital - 3b-Student attended religious activities** | Student attends religious activities |
| **Social Capital - 3 Other-Other community involvement** | Volunteered at civic or community center in past yr |
| **Social Capital - 4b-Institutional agents support student's academic achievement** | (Institutional Agent) teacher helped student with homework |
| **Social Capital - 4 other-Other social capital within schools** | Received services from formal counseling (personal, academic, financial, or career) |
| **Educational expectations** | Expected occupation is in science |
| **Higher education Status** | Number of Post-Secondary education (PSE) institutions attended |
| **HE- Academic social capital** | Had courses in Biology |
| **HE- Non-academic social capital** | Have gone to play, concert or museum in last year |
| **Negative social capital** | Has student ever dropped out of school |

Items from Ream (2005) were categorized as theoretically and empirically measuring social capital within families, social capital among peers, social capital within the community, and social capital within schools. He also outlined four dimensions to social capital within families or and (a) parent/sibling involvement in student's education, (b) parent/student bond, (c) intergenerational closure among parents and students, where the parents of a student know the parents of friends and peers of their student, and (d) parents involvement in in-school activities. These have been labelled as social capital -1a, 1b, 1c, and 1d for identification in Table II, and for discussion. Social capital among peers was measured along three dimensions: (a) student's connections with peers, (b) student is friendly with other racial groups, and (c) student's friends prioritize education, and have been labelled as social capital -2a, 2b, and 2c. Social capital within the community, was measured along 2 dimensions (a) Student/parent participates in community, and (b) student attend religious activities, and have been labelled as social capital- 3a, and 3b. Lastly, social capital within schools was measured across 2 dimensions, (a) institutional agents demonstrating caring towards students and (b) institutional agents support students' academic achievement and were labelled as 4a and 4b (see appendix for full listing of items description).

***Exploratory Factor Analysis.***

To examine if the social capital groupings from Ream (2005) are indeed different constructs and that have previously been identified as measuring underlying constructs (Dika & Singh, 2002), a Maximum Likelihood factor analysis with Promax rotation was used. Given the large number of items, more conservative eigenvalue cutoffs (>2, rather than >1), and loadings greater than .4 were identified. Only scale items were used in the factor analysis, since factor analysis methods for mixed datasets is not commonly practiced, although latent-variable methods have shown promise for doing this analysis (Holst, Budtz-Jørgensen, & Knudsen, 2015; Quinn 2004).

***Regression Models for persistence models.***

The model used was a binary probit ridge regression model to predict 1$^{st}$ and 2$^{nd}$ year persistence. Ridge regressions are regressions that correct for multicollinearity by penalizing covariates to reduce bias (Hastie, Buja, & Tibshirani, 1995; Karabatsos, 2017; Zhang, Dai, Xu, & Jordan, 2010). Increasing the number of covariates, or predictor measures, in models introduces multicollinearity. With social capital theoretically made of items with similar underlying construct(s) multicollinearity of covariates is expected. Probit models are used when the outcome variables are discrete, and binary models when there are two discrete outcomes. Persistence in the major, has two discrete outcomes of persistence or attrition, and so a binary probit model was employed.

The general model employed for analysis of 1$^{st}$ and 2$^{nd}$ year persistence models using NELS data was:

$$
\begin{aligned}
y_i \mid \mathbf{x}_i &\sim f(y \mid \mathbf{x}_i), \quad i = 1, \ldots, n \\
f(y \mid \mathbf{x}) &= F^*(\mathbf{x}^\intercal \boldsymbol{\beta})^y [1 - F^*(\mathbf{x}^\intercal \boldsymbol{\beta})]^{1-y} \\
\beta_0 &\propto 1 \\
(\beta_k)_{k=1}^{p} \mid \lambda &\sim \mathrm{N}(\mathbf{0}, (\sigma^2/\lambda)\mathbf{I}_p) \\
\lambda &\sim \mathrm{Ga}(\delta_1, \delta_2).
\end{aligned}
$$

where the probability of persistence (1-yr and 2$^{-}$ yr) was predicted based on social capital variables from Ream (2005), educational expectations, higher education status, higher education social capital and negative social capital.

Propensity scores were used as covariates as an approach to identify baseline differences that exist between groups (Rosenbaum & Rubin, 1983; Schultz, Hernandez, Woodcock, Estrada, Chance, Aguilar, & Serpe, 2011; Winship & Morgan, 1999). In this model, propensity scores were calculated for different science majors to identify for baseline differences between students in different majors that may exist, as identified in the higher education literature (Chen, 2013).

***Validity concerns and limitations.***

There are a number of limitations to this analysis. First, this data was not initially constructed to measure social capital, even though there is a tradition of using these items as proxy measures for social capital (Dika & Singh, 2002; Ream, 2005). This presents issues in the interpretation of the data, as proxies can only capture so much of the underlying construct or measure (Van Deth, 2003) and introduces error into the model, although proxy measures are sometimes necessary given the dearth of better measures (Roche & Roberts, 2001). Second, this data was collected at multiple timepoints, making it is difficult to pinpoint experiences that may have occurred over a wide large timeframe, or raise concerns of inconsistency in memory of an experience. Such items as drawing on formal tutoring process, was measured up to 8 years after high school. If tutoring occurred in the first year of higher education, it may have been forgotten, if it occurred in later years of school. This timing then would make it inappropriate for predicting 1-yr and 2-yr persistence and is a limitation of the dataset. This dataset is not representative, as the survey was initially constructed to be representative of US 8$^{th}$ graders, who were the initial survey sample, and weights were developed. As the 4-yr college going is also not representative of weights would need to be recalculated, and the NELS 88:00 suggest against this if combining items from multiple surveys, as was done here (F2, F3, and F4).

An additional concern is the timing of item measurement. F4 items were measured approximately eight years after beginning of higher education, and memory effects may introduce measurement error. Related, higher education experiences from F4 surveys may have occurred after or partially after the outcome variable of persistence, but theoretically may still be measuring social capital by proxy. Regardless, this affects validity of the measured effect.

With respect to the model, ridge regression penalizes coefficients in order to reduce correlation between predictors in ordinary least-squares (OLS) models, by introducing bias (Karabatsos, 2017). For this reason, ridge regression is able to reduce collinearity, but validity is affected because of the introduced bias.

Additionally, Bayesian models are sensitive to priors, and a simple sensitivity analysis was performed to examine the impact of modifying priors on posterior distributions. Muller (2012) notes, that current accepted practice includes either comparing marginal prior /posterior distributions or comparing the difference in variance across different values of the priors, although these may not be the most informative analyses. This study used this latter approach and a comparison of model variances ($R^2$) across different values of priors ($\delta_1$,$\delta_2$) was examined.

**Research Question Two and Three: Survey and Interviews at UNIV.**

This section outlines the study portion that took place at UNIV, that used a designed survey and semi-structured interviews. These will be presented sequentially, as they answered different research questions, but are organized together here, as they share the same institutional setting and population from which students were sampled. First, the institutional setting will be discussed, including student demographics, representation in science majors, and retention data, as they are the same for both the survey and the semi-structured interviews. Then, the sample and design of the survey will be discussed, followed by the models used on factors theoretically linked to persistence. Then, the semi-structured interview sample, survey design and analysis we be discussed.

***Institutional Setting.***

The participants for this mixed-study were drawn from students enrolled at a large, public, research institution in a large urban city that offers 4-yr science programs and was in the process of receiving designation as a Hispanic Serving Institution (HSI). While this university (pseudonym UNIV) was in the process of attaining HSI designation, it was already recognized as a minority serving institution. This institution's retention data for the cohort of students entering in 2012 (most recent for cohort of students studied) was 79.8%, and the six-year graduation rates for cohorts that began in 2006 and 2007 was 58% and 57% respectively (CDS, 2014). Consistent with measures reported to IPEDS (NCES, 2018), retention was operationalized as the percentage of students that were enrolled at the institution in the fall semester after being enrolled in the previous year's fall semester. Six-yr graduation rates were measured by the number of graduates that completed any degree, six years after initially enrolling as first-time students. Of the 2010 incoming freshman, 1% received federal financial aid, had an average ACT of 23.8, and ended their first semester with an average GPA of 2.72 (CDS, 2014).

Racial/ethnic demographics of the student body as reported by college are reported below, along with their continuation rates, or rates of persistence, and persistence beyond the fourth year without graduating, in Table III. Table IV similarly presents data, but along gender. Success rates, defined by UNIV as either still being enrolled or graduating by the 6$^{th}$ year after starting as a 1$^{st}$ time student at UNIV, are presented in Table V. This shows that graduation rates vary by college, and by racial/ethnic group within different colleges, a trend seen nationally (PCAST, 2012; Seymour & Hewitt, 1997). Table VI shows the 6-yr graduation rates over time, showing graduation rates comparable with that of all 4-yr students at this institution (NSF, 2014; PCAST, 2012).

As seen in Table VII and Table VIII, fields like nursing have 4-yr and 6-yr graduation rates at 75% and above, with the average above 90%, and Asian students, with White students often used as the reference group for comparison, having the lowest graduation rates. Yet, as these are different cohorts, caution for comparison is advised. For example, for the cohort that gradated in 2018 in other sciences (mathematics, and computer sciences), Latinx students had the lowest graduation rates when comparing racial/ethnic groups of students, while in the cohort that would graduate within six years in 2018, Latinx students had the highest rates of graduation.

Demographics for retention across racial/ethnic groups are available for freshman cohorts from 2004 until 2008 (in Table VI), with identification of status as having graduated, still enrolled, dropout in good or bad standing and dropout for unknown reason given. Of particular concern is the high percentages of students that dropout in good standing, accounting for nearly 1/6 (14.7% for the 2008-2014 cohort) of students. An additional concern is the high rates of dropouts in poor standing among Black students (41%) and Latinx students (25.8%).

Additionally, while graduation rates have increased for students identifying as of Black and Hispanic racial/ethnicity over time, six-year graduation rates were at rates as low as 24.5% for Black students for the 2001-2007 cohort and as low as 38.3% for Latinx students for the 2002-2006 cohort (data not in table). Possible systemic issues at the university may be at play, as the 2001 and the 2002 cohorts in total had six-year graduation rates of 48.9% and 47.4% respectively, and these numbers are far below the current six-year graduation rate of 59.7%. An additional factor that may be influencing these rates is that the institution began counting only first-time, full-time freshman starting with the 2003 cohort, raising rates of graduation to 54.1%

*TABLE III. Continuation rates for Black, Hispanic, Asian, and White students until the 6$^{th}$ year of* attendance, cohort years 2005-2010.
Source: CDS (2014).

| Cohort Type | Cohort Year | N | %Cont to_2nd_Yr | %Cont to_3rd_Yr | %Grad in_4_Yrs | %Cont to_5th_Yr | %Grad in_5_Yrs | %Cont to_6th_Yr |
|---|---|---|---|---|---|---|---|---|
| **Black** | 2005 | 296 | 66.2% | 44.6% | 17.6% | 19.6% | 28.0% | 6.1% |
| **Black** | 2006 | 268 | 66.8% | 52.2% | 14.9% | 26.1% | 35.1% | 6.7% |
| **Black** | 2007 | 345 | 66.1% | 52.8% | 17.4% | 28.7% | | |
| **Black** | 2008 | 311 | 73.6% | 58.8% | | | | |
| **Black** | 2009 | 301 | 75.1% | 55.5% | | | | |
| **Black** | 2010 | 291 | 73.9% | | | | | |
| **Hispanic** | 2005 | 551 | 76.4% | 57.2% | 13.6% | 37.9% | 34.5% | 14.3% |
| **Hispanic** | 2006 | 469 | 72.9% | 63.5% | 16.4% | 38.8% | 40.9% | 13.2% |
| **Hispanic** | 2007 | 591 | 71.1% | 62.3% | 16.2% | 37.6% | | |
| **Hispanic** | 2008 | 585 | 79.7% | 69.1% | | | | |
| **Hispanic** | 2009 | 690 | 78.7% | 70.0% | | | | |
| **Hispanic** | 2010 | 734 | 77.3% | | | | | |
| **Asian** | 2005 | 725 | 86.9% | 76.4% | 37.5% | 30.9% | 59.6% | 7.9% |
| **Asian** | 2006 | 770 | 87.7% | 76.1% | 37.9% | 30.3% | 59.9% | 8.4% |
| **Asian** | 2007 | 817 | 87.4% | 74.4% | 36.2% | 32.1% | | |
| **Asian** | 2008 | 700 | 87.0% | 78.4% | | | | |
| **Asian** | 2009 | 752 | 88.2% | 79.7% | | | | |
| **Asian** | 2010 | 783 | 87.9% | | | | | |
| **White** | 2005 | 1009 | 77.9% | 67.1% | 28.3% | 32.5% | 50.6% | 8.2% |
| **White** | 2006 | 1153 | 78.0% | 66.9% | 34.9% | 26.6% | 56.4% | 4.7% |
| **White** | 2007 | 1335 | 77.8% | 67.3% | 35.2% | 26.1% | | |
| **White** | 2008 | 1178 | 79.8% | 71.1% | | | | |
| **White** | 2009 | 1209 | 81.9% | 71.6% | | | | |
| **White** | 2010 | 1191 | 77.2% | | | | | |

across the institution from 47.4%, suggesting that part-time students are retained at lower rates than full-time students, a conclusion supported by prior research (Bean & Metzner, 1985).

It is important to note that the lack of data parsing for gender and racial/ethnic background combined makes it difficult to identify any issues that may be disproportionately affecting underrepresented minority males or underrepresented minority females (Saenz & Ponjuan, 2009), possibly not done given the small number of students in some majors. For example, there was only four students identifying as AINA in the 2008 cohort, and only one

*TABLE IV. Continuation rates for All students, Female students, and Male students until the 6th year of attendance. Cohort years 2005-2010.* Source: CDS (2014).

| Cohort Type | Cohort Year | N | %Cont to_2nd_Yr | %Cont to_3rd_Yr | %Grad in_4_Yrs | %Cont to_5th_Yr | %Grad in_5_Yrs | %Cont to_6th_Yr |
|---|---|---|---|---|---|---|---|---|
| **Total** | 2005 | 2759 | 79.2% | 65.5% | 26.8% | 31.7% | 47.4% | 9.1% |
| **Total** | 2006 | 2830 | 78.6% | 67.4% | 30.8% | 29.8% | 52.8% | 7.5% |
| **Total** | 2007 | 3272 | 77.7% | 66.5% | 29.8% | 30.1% | | |
| **Total** | 2008 | 2944 | 80.6% | 70.9% | | | | |
| **Total** | 2009 | 3126 | 81.7% | 71.3% | | | | |
| **Total** | 2010 | 3185 | 79.4% | | | | | |
| **Female** | 2005 | 1534 | 79.6% | 64.7% | 29.1% | 28.4% | 48.8% | 7.7% |
| **Female** | 2006 | 1554 | 78.4% | 67.1% | 31.9% | 27.3% | 52.9% | 6.0% |
| **Female** | 2007 | 1813 | 76.5% | 64.6% | 32.3% | 26.6% | | |
| **Female** | 2008 | 1659 | 79.7% | 69.7% | | | | |
| **Female** | 2009 | 1680 | 82.7% | 71.2% | | | | |
| **Female** | 2010 | 1731 | 79.6% | | | | | |
| **Male** | 2005 | 1225 | 78.7% | 66.6% | 23.8% | 35.9% | 45.8% | 10.8% |
| **Male** | 2006 | 1276 | 78.8% | 67.9% | 29.5% | 32.8% | 52.6% | 9.4% |
| **Male** | 2007 | 1459 | 79.1% | 68.8% | 26.7% | 34.5% | | |
| **Male** | 2008 | 1285 | 81.7% | 72.5% | | | | |
| **Male** | 2009 | 1446 | 80.6% | 71.4% | | | | |
| **Male** | 2010 | 1454 | 79.2% | | | | | |

*TABLE V. 6-Year Success (Graduation/Still Enrolled) Rates by Starting College and Race/Ethnicity, Full-time Freshmen, 2008 and 6-yr graduation by 2014. Source: CDS (2014).*

| | | | | | *Fall 2008* | | |
|---|---|---|---|---|---|---|---|
| ***Colleges*** | *Race/Ethnicity* | *N* | *% in college* | *Grad.* | ***%Grad*** | *Enr.* | *Success* |
| ***Engineering*** | *1 AIAN** | 0 | 0.0 | 0 | **n/a** | 0 | -- |
| | *2 Asian* | 69 | 22.8 | 41 | **59.4** | 7 | 69.6 |
| | *3 Black NonHispanic* | 18 | 6.0 | 4 | **22.2** | 2 | 33.3 |
| | *4 Hispanic* | 43 | 14.2 | 17 | ***39.5*** | 4 | 48.8 |
| | *5 White* | 145 | 48.0 | 83 | **57.2** | 6 | 61.4 |
| | *6 International* | 10 | 3.3 | 8 | **80** | 0 | 80 |
| | *7 Unknown* | 17 | 5.6 | 12 | **70.6** | 2 | 82.4 |
| ***Liberal Arts & Sciences*** | *1 AIAN** | 3 | 0.1 | 2 | **66.7** | 0 | 66.7 |
| | *2 Asian* | 546 | 26.1 | 363 | **66.5** | 26 | 71.2 |
| | *3 Black NonHispanic* | 230 | 11.0 | 107 | **46.5** | 5 | 48.7 |
| | *4 Hispanic* | 441 | 21.1 | 252 | ***57.1*** | 23 | 62.4 |
| | *5 White* | 755 | 36.1 | 471 | **62.4** | 14 | 64.2 |
| | *6 International* | 23 | 1.1 | 17 | **73.9** | 1 | 78.3 |
| | *7 Unknown* | 96 | 4.6 | 57 | **59.4** | 2 | 61.5 |
| **All Colleges** | *1 AIAN** | 4 | 0.1 | 2 | **50 .** | | 50 |
| | *2 Asian* | 700 | 23.8 | 457 | **65.3** | 39 | 70.9 |
| | *3 Black NonHispanic* | 311 | 10.6 | 135 | **43.4** | 9 | 46.3 |
| | *4 Hispanic* | 585 | 19.9 | 328 | ***56.1*** | 31 | 61.4 |
| | *5 White* | 1,178 | 40.0 | 731 | **62.1** | 26 | 64.3 |
| | *6 International* | 38 | 1.3 | 27 | **71.1** | 1 | 73.7 |
| | *7 Unknown* | 128 | 4.3 | 77 | **60.2** | 5 | 64.1 |
| **Total** | | 2,944 | | 1757 | **59.7** | 111 | 63.5 |

*TABLE VI. 6-yr graduation, continuation rates, and dropout rates by racial/ethnic groups for Full-time Freshman Cohort, 2008-2012. Source: CDS (2014).*

| Cohort Year | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|
| **Graduation by Summer:** | 2010 | 2011 | 2012 | 2013 | 2014 |
| | | | | | |
| **Asian** | 676 | 725 | 770 | 817 | 700 |
| **%Graduated** | 59.0 | 65.0 | 64.6 | 65.4 | 65.3 |
| **%Still Enrolled** | 3.0 | 3.9 | 4.2 | 2.8 | 5.6 |
| **% Dropout, good standing** | 13.2 | 12.0 | 14.0 | 12.7 | 13.1 |
| **% Dropout, poor standing** | 24.3 | 18.9 | 17.0 | 18.9 | 15.9 |
| **% Dropout, unknown** | 0.6 | 0.3 | 0.3 | 0.2 | 0.1 |
| | | | | | |
| **Black** | 266 | 296 | 268 | 345 | 311 |
| **%Graduated** | 38.3 | 33.4 | 38.3 | 44.1 | 43.3 |
| **%Still Enrolled** | 2.3 | 3.4 | 3.7 | 1.7 | 2.9 |
| **% Dropout, good standing** | 8.6 | 10.8 | 11.9 | 8.1 | 10.9 |
| **% Dropout, poor standing** | 49.2 | 52.0 | 44.8 | 44.1 | 41.2 |
| **% Dropout, unknown** | 1.6 | 0.3 | 0.8 | 2.0 | 1.6 |
| | | | | | |
| **Hispanic** | 493 | 551 | 469 | 591 | 585 |
| **%Graduated** | 39.6 | 45.6 | 50.8 | 48.6 | 56.1 |
| **%Still Enrolled** | 6.3 | 6.2 | 4.9 | 5.3 | 5.3 |
| **% Dropout, good standing** | 11.2 | 10.0 | 10.7 | 13.2 | 12.0 |
| **% Dropout, poor standing** | 42.2 | 37.2 | 32.8 | 32.2 | 25.8 |
| **% dropout, unknown** | 0.8 | 1.1 | 0.9 | 0.9 | 0.9 |
| | | | | | |
| **White** | 983 | 1,009 | 1,153 | 1,335 | 1,178 |
| **%Graduated** | 58.3 | 57.1 | 59.5 | 58.3 | 62.1 |
| **%Still Enrolled** | 3.6 | 3.9 | 2.2 | 3.4 | 2.2 |
| **% Dropout, good standing** | 16.6 | 16.0 | 16.7 | 18.1 | 18.6 |
| **% Dropout, poor standing** | 21.1 | 21.1 | 21.0 | 19.1 | 16.6 |
| **% dropout, unknown** | 0.5 | 2.0 | 0.7 | 1.1 | 0.6 |
| | | | | | |
| **Total** | 1671 | 2,759 | 2,830 | 3,272 | 2,944 |
| **%Graduated** | 53.0 | 54.5 | 57.7 | 56.7 | 59.7 |
| **%Still Enrolled** | 3.7 | 4.3 | 3.4 | 3.3 | 3.8 |
| **% Dropout, good standing** | 13.9 | 13.0 | 14.1 | 14.9 | 14.7 |
| **% Dropout, poor standing** | 28.7 | 27.1 | 24.2 | 24.2 | 21.0 |
| **% Dropout, unknown** | 0.7 | 1.2 | 0.6 | 0.9 | 0.8 |

student identifying as AINA in all of current LAS science majors (Table IX), the population for this study. Furthermore, while the literature cites the importance of the first two years of undergraduate education for predicting persistence, the institutional data presented here suggests that for Black and Latinx students, the third year is as a big of a hurdle as is the first and second

*TABLE VII. 6-yr graduation rates for 2011 cohort (latest available) by race/ethnicity. Note: * Nursing reported graduation rates for students that entered at multiple points because of the nature of the degree, and so were not combined with other life sciences. ** Values suppressed because of N<5.*

| 6 Year Grad Rate – Life sciences w/out Nursing | | | | 6 Year Grad Rate – Physical Sciences | | | |
|---|---|---|---|---|---|---|---|
| | **N** | **Grad** | **%Grad** | | **N** | **Grad** | **%Grad** |
| **Asian** | 175 | 129 | 74 | **Asian** | 44 | 33 | 75 |
| **Black/African American** | 43 | 21 | 49 | **Black/African American** | 13 | 3 | 23 |
| **Hispanic** | 94 | 50 | 53 | **Hispanic** | 25 | 10 | 40 |
| **International** | ** | ** | ** | **International** | ** | ** | ** |
| **Multi-Race** | 13 | 8 | 62 | **Multi-Race** | ** | ** | ** |
| **NHPI** | ** | ** | ** | **NHPI** | ** | ** | ** |
| **Unknown** | ** | ** | ** | **Unknown** | ** | ** | ** |
| **White** | 140 | 106 | 76 | **White** | 44 | 27 | 61 |
| **TOTAL** | 478 | 324 | 68 | **TOTAL** | 134 | 80 | 60 |
| **6 Year Grad Rate – Other Sciences** | | | | **6 Year Grad Rate - *Nursing** | | | |
| | **N** | **Grad** | **%Grad** | | **N** | **Grad** | **%Grad** |
| **Asian** | 21 | 9 | 43 | **Asian** | 17 | 14 | 82 |
| **Black/African American** | ** | ** | ** | **Black/African American** | 20 | 18 | 90 |
| **Hispanic** | 15 | 10 | 67 | **Hispanic** | 17 | 17 | 100 |
| **International** | ** | ** | ** | **International** | ** | ** | ** |
| **Multi-Race** | ** | ** | ** | **Multi-Race** | ** | ** | ** |
| **Unknown** | ** | ** | ** | **NHPI** | ** | ** | ** |
| **White** | 25 | 10 | 40 | **Unknown** | ** | ** | ** |
| **TOTAL** | 67 | 33 | 49 | **White** | 90 | 87 | 97 |
| | | | | **TOTAL** | 156 | 148 | 95 |

years, suggesting factors persistently affecting these students beyond those seen as affecting all students during this time.

Additionally, at the time of this study, the university was in the process of becoming an HSI, and so it is not surprising to see students identifying as Hispanic generally representing a quarter to a third of the students in a major, with the exception of biochemistry majors (Table X). Latinx students may also be captured in the international, multi-race, and unknown categories, based on immigration status or national identification over ethnicity. It is also important

*TABLE VIII. 4-yr graduation rates for 2013 cohort (latest available) by race/ethnicity. Note: * Nursing reported graduation rates for students that entered at multiple points because of the nature of the degree, and so were not combined with other life sciences. ** Values suppressed because of N<5.*

| 4 Year Grad Rate – Life Science w/out nursing | | | | 4 Year Grad Rate – Physical Science | | | |
|---|---|---|---|---|---|---|---|
| | **N** | **Grad** | **%Grad** | | **N** | **Grad** | **%Grad** |
| **AIAN** | ** | ** | ** | **Asian** | 52 | 26 | 50 |
| **Asian** | 215 | 127 | 59 | **Black/African American** | 10 | 1 | 10 |
| **Black/African American** | 71 | 22 | 31 | **Hispanic** | 28 | 8 | 29 |
| **Hispanic** | 131 | 41 | 31 | **International** | ** | ** | ** |
| **International** | ** | ** | ** | **Multi-Race** | ** | ** | ** |
| **Multi-Race** | 13 | 0 | 0 | **Unknown** | ** | ** | ** |
| **NHPI** | ** | ** | ** | **White** | 47 | 14 | 30 |
| **Unknown** | 13 | 5 | 38 | **TOTAL** | 147 | 51 | 35 |
| **White** | 178 | 81 | 46 | | | | |
| **TOTAL** | 632 | 281 | 44 | | | | |

| **4 Year Grad Rate – Other science** | | | | **4 Year Grad Rate - *Nursing** | | | |
|---|---|---|---|---|---|---|---|
| | **N** | **Grad** | **%Grad** | | **N** | **Grad** | **%Grad** |
| **Asian** | 33 | 15 | 45 | **Asian** | 24 | 18 | 75 |
| **Black/African American** | ** | ** | ** | **Black/African American** | 14 | 12 | 86 |
| **Hispanic** | 29 | 6 | 21 | **Hispanic** | 13 | 12 | 92 |
| **International** | ** | ** | ** | **International** | ** | ** | ** |
| **Multi-Race** | ** | ** | ** | **Multi-Race** | ** | ** | ** |
| **NHPI** | ** | ** | ** | **Unknown** | ** | ** | ** |
| **Unknown** | ** | ** | ** | **White** | 95 | 91 | 96 |
| **White** | 33 | 14 | 42 | **TOTAL** | 162 | 148 | 91 |
| **TOTAL** | 108 | 38 | 35 | | | | |

to note that students identifying as Asian or Pacific Islander, are overrepresented, and students identifying as White, are underrepresented in science majors, compared to their representation in the university. This too is not surprising as the university was a minority serving institution at the time of this study.

As far as gender, representation varied by field and by major for Latinx students. Biochemistry had near parity, but chemistry, physics, and other science majors were all

*TABLE IX. Representation of students in physical science majors and field, by race/ethnicity and by gender.*
*Note: Racial/ethnic categories as described by UNIV.*

| **% of total students BY RACE/ethnicity in major** | | | | | **% of total students BY GENDER in major** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Chemistry** | T | M | F | U | **Chemistry** | T | M | F | U |
| **AINA** | 0 | 0 | 0 | 0 | **AINA** | 0 | 0 | 0 | 0 |
| **Asian/Pacific Islander** | 29 | 27 | 30 | 0 | **Asian/Pacific Islander** | 100 | 44 | 56 | 0 |
| **African-American/Black** | 5 | 6 | 5 | 0 | **African-American/Black** | 100 | 50 | 50 | 0 |
| **Hispanic** | 24 | 31 | 19 | 0 | **Hispanic** | 100 | 58 | 42 | 0 |
| **International** | 3 | 2 | 4 | 0 | **International** | 100 | 25 | 75 | 0 |
| **Multi-race** | 3 | 2 | 5 | 0 | **Multi-race** | 100 | 22 | 78 | 0 |
| **Unknown** | 1 | 1 | 1 | 0 | **Unknown** | 100 | 50 | 50 | 0 |
| **White** | 34 | 32 | 36 | 0 | **White** | 100 | 44 | 56 | 0 |
| **total** | 100 | 100 | 100 | 0 | **Total** | 100 | 47 | 53 | 0 |
| | | | | | | | | | |
| **Physics** | T | M | F | U | **Physics** | T | M | F | U |
| **AINA** | 0 | 0 | 0 | 0 | **AINA** | 0 | 0 | 0 | 0 |
| **Asian/Pacific Islander** | 20 | 19 | 22 | 0 | **Asian/Pacific Islander** | 100 | 75 | 25 | 0 |
| **African-American/Black** | 3 | 3 | 0 | 0 | **African-American/Black** | 100 | 100 | 0 | 0 |
| **Hispanic** | 28 | 29 | 22 | 0 | **Hispanic** | 100 | 82 | 18 | 0 |
| **International** | 3 | 0 | 11 | 0 | **International** | 100 | 0 | 100 | 0 |
| **Multi-race** | 0 | 0 | 0 | 0 | **Multi-race** | 0 | 0 | 0 | 0 |
| **Unknown** | 3 | 3 | 0 | 0 | **Unknown** | 100 | 100 | 0 | 0 |
| **White** | 45 | 45 | 44 | 0 | **White** | 100 | 78 | 22 | 0 |
| | 100 | 100 | 100 | | | | | | |
| | | | | | | | | | |
| **EES** | T | M | F | U | **EES** | T | M | F | U |
| **AINA** | 0 | 0 | 0 | 0 | **AINA** | 0 | 0 | 0 | 0 |
| **Asian/Pacific Islander** | 3 | 2 | 3 | 0 | **Asian/Pacific Islander** | 100 | 50 | 50 | 0 |
| **African-American/Black** | 6 | 4 | 9 | 0 | **African-American/Black** | 100 | 40 | 60 | 0 |
| **Hispanic** | 32 | 22 | 47 | 0 | **Hispanic** | 100 | 40 | 60 | 0 |
| **International** | 1 | 2 | 0 | 0 | **International** | 100 | 100 | 0 | 0 |
| **Multi-race** | 3 | 2 | 3 | 0 | **Multi-race** | 100 | 50 | 50 | 0 |
| **Unknown** | 1 | 2 | 0 | 0 | **Unknown** | 100 | 100 | 0 | 0 |
| **White** | 41 | 29 | 12 | 0 | **White** | 100 | 71 | 29 | 0 |
| | 100 | 100 | 100 | 0 | | 100 | 58 | 42 | 0 |

| PHYSICAL | T | M | F | U | PHYSICAL | T | M | F | U |
|---|---|---|---|---|---|---|---|---|---|
| **AINA** | 0 | 0 | 0 | 0 | **AINA** | 0 | 0 | 0 | 0 |
| **Asian/Pacific Islander** | 23 | 21 | 25 | 0 | **Asian/Pacific Islander** | 100 | 47 | 53 | 0 |
| **African-American/Black** | 5 | 5 | 5 | 0 | **African-American/Black** | 100 | 50 | 50 | 0 |
| **Hispanic** | 26 | 29 | 24 | 0 | **Hispanic** | 100 | 56 | 44 | 0 |
| **International** | 3 | 2 | 4 | 0 | **International** | 100 | 30 | 70 | 0 |
| **Multi-race** | 3 | 2 | 4 | 0 | **Multi-race** | 100 | 27 | 73 | 0 |
| **Unknown** | 1 | 2 | 1 | 0 | **Unknown** | 100 | 75 | 25 | 0 |
| **White** | 39 | 42 | 37 | 0 | **White** | 100 | 55 | 45 | 0 |
| | 100 | 100 | 100 | 0 | | 100 | 52 | 48 | 0 |

overrepresented by students identifying as male, while in earth and environmental sciences, biology, and nursing were overrepresented by students identifying as female. Physics and nursing had the widest disparities in gender, with four times as many students identifying as Hispanic women than men in nursing and four times as many students identifying as men than women in physics. It is also important to note that all students who identified as unknown gender, possibly because of being gender non-conforming. Since studies examining the proportion of people that identify as neither male or female varies from 0.8-3.5% of the population depending on major, it is possible that this population is undermeasured in the population of students. Lastly, all these students were also in life science majors, but the significance of this is uncertain, although Risman (2017) suggests that students are increasingly challenging gender identification as binary.

*TABLE X. Representation of students in life science majors and field, by race/ethnicity and by gender.*
*Note: Racial/ethnic categories reported by categories of UNIV.*

| **% of students By RACE/ethnicity in major** | | | | | **% of students By GENDER in major** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Biological sciences** | T | M | F | U | **Biological sciences** | T | M | F | U |
| **AINA** | 0 | 0 | 0 | 0 | **AINA** | 100 | 0 | 100 | 0 |
| **Asian/Pacific Islander** | 35 | 38 | 32 | 33 | **Asian/Pacific Islander** | 100 | 44 | 56 | 0 |
| **African-American/Black** | 8 | 4 | 10 | 0 | **African-American/Black** | 100 | 19 | 81 | 0 |
| **Hispanic** | 23 | 21 | 25 | 0 | **Hispanic** | 100 | 36 | 64 | 0 |
| **International** | 2 | 2 | 2 | 33 | **International** | 100 | 33 | 63 | 3 |
| **Multi-race** | 3 | 3 | 3 | 0 | **Multi-race** | 100 | 40 | 60 | 0 |
| **Unknown** | 1 | 1 | 1 | 0 | **Unknown** | 100 | 54 | 46 | 0 |
| **White** | 29 | 31 | 28 | 33 | **White** | 100 | 42 | 58 | 0 |
| | 100 | 100 | 100 | 100 | | 100 | 39 | 61 | 0 |
| **Biochemistry** | T | M | F | U | **Biochemistry** | T | M | F | U |
| **AINA** | 0 | 0 | 0 | 0 | **AINA** | 0 | 0 | 0 | 0 |
| **Asian/Pacific Islander** | 35 | 35 | 34 | 0 | **Asian/Pacific Islander** | 100 | 47 | 53 | 0 |
| **African-American/Black** | 10 | 5 | 14 | 0 | **African-American/Black** | 100 | 24 | 76 | 0 |
| **Hispanic** | 17 | 19 | 15 | 0 | **Hispanic** | 100 | 52 | 48 | 0 |
| **International** | 2 | 1 | 3 | 0 | **International** | 100 | 12 | 88 | 0 |
| **Multi-race** | 5 | 5 | 5 | 0 | **Multi-race** | 100 | 47 | 53 | 0 |
| **Unknown** | 1 | 1 | 0 | 0 | **Unknown** | 100 | 100 | 0 | 0 |
| **White** | 31 | 34 | 29 | 100 | **White** | 100 | 49 | 50 | 1 |
| | 100 | 100 | 100 | 100 | | 100 | 46 | 54 | 0 |
| **Nursing** | T | M | F | U | **Nursing** | T | M | F | U |
| **AINA** | 0 | 0 | 0 | 0 | **AINA** | 0 | 0 | 0 | 0 |
| **Asian/Pacific Islander** | 24 | 17 | 26 | 0 | **Asian/Pacific Islander** | 100 | 14 | 86 | 0 |
| **African-American/Black** | 8 | 11 | 7 | 0 | **African-American/Black** | 100 | 27 | 73 | 0 |
| **Hispanic** | 27 | 25 | 28 | 0 | **Hispanic** | 100 | 18 | 82 | 0 |
| **International** | 0 | 0 | 0 | 0 | **International** | 0 | 0 | 0 | 0 |
| **Multi-race** | 1 | 3 | 0 | 0 | **Multi-race** | 100 | 100 | 0 | 0 |
| **Unknown** | 1 | 3 | 0 | 0 | **Unknown** | 100 | 100 | 0 | 0 |
| **White** | 40 | 42 | 40 | 0 | **White** | 100 | 20 | 80 | 0 |
| | 100 | 100 | 100 | 0 | | 100 | 19 | 81 | 0 |
| **LIFE** | T | M | F | U | **LIFE** | T | M | F | U |
| **AINA** | 0 | 0 | 0 | 0 | **AINA** | 100 | 0 | 100 | 0 |
| **Asian/Pacific Islander** | 34 | 37 | 32 | 25 | **Asian/Pacific Islander** | 100 | 42 | 58 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **African-American/Black** | 8 | 4 | 10 | 0 | **African-American/Black** | 100 | 21 | 79 | 0 |
| **Hispanic** | 22 | 21 | 23 | 0 | **Hispanic** | 100 | 36 | 64 | 0 |
| **International** | 2 | 1 | 2 | 25 | **International** | 100 | 29 | 68 | 3 |
| **Multi-race** | 3 | 3 | 3 | 0 | **Multi-race** | 100 | 43 | 57 | 0 |
| **Unknown** | 1 | 1 | 0 | 0 | **Unknown** | 100 | 63 | 38 | 0 |
| **White** | 30 | 32 | 29 | 50 | **White** | 100 | 41 | 59 | 0 |
| | 100 | 100 | 100 | 100 | | 100 | 39 | 61 | 0 |

*TABLE XI. Representation of students in other science majors and field, by race/ethnicity and by gender. Racial/ethnic categories reported by categories of UNIV.*

| **% BY RACE/ethnicity in major** | | | | | **% BY GENDER in major** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **OTHER** | T | M | F | U | **OTHER** | T | M | F | U |
| **AINA** | 0 | 0 | 0 | 0 | **AINA** | 0 | 0 | 0 | 0 |
| **Asian/Pacific Islander** | 38 | 37 | 42 | 0 | **Asian/Pacific Islander** | 100 | 72 | 28 | 0 |
| **African-American/Black** | 10 | 7 | 19 | 0 | **African-American/Black** | 100 | 50 | 50 | 0 |
| **Hispanic** | 27 | 29 | 23 | 0 | **Hispanic** | 100 | 79 | 21 | 0 |
| **International** | 1 | 1 | 0 | 0 | **International** | 100 | 100 | 0 | 0 |
| **Multi-race** | 1 | 1 | 0 | 0 | **Multi-race** | 100 | 100 | 0 | 0 |
| **Unknown** | 0 | 0 | 0 | 0 | **Unknown** | 0 | 0 | 0 | 0 |
| **White** | 23 | 25 | 15 | 100 | **White** | 100 | 79 | 17 | 4 |
| **TOTAL** | 100 | 100 | 100 | 100 | **TOTAL** | 100 | 74 | 25 | 1 |

***Research question two: Survey.***

The following section delves into the survey designed to answer the following research question:

*Do life and physical science majors in an emerging Hispanic-Serving institution differ on measures theorized to impact persistence?*

*Do students differ on measures of academic-based social capital, constructed using items from Stanton-Salazar (2001)?*

*Do students in life and physical and science majors differ on measures of GPA, science identity, and racial campus climate that are theorized to impact persistence?*

This section beings by describing the sample form UNIV for the survey, followed by a description of the survey design, the models examined using this data, and validity concerns.

***Sample for UNIV survey.***

The students solicited to take the survey were from a listing of students that were in science majors within in the College of Liberal Arts and Sciences. Since students within the same college have the same general education requirements, this allows for more consistent comparisons between fields. Students in other majors also take classes within this college, such as engineering, nutrition, and kinesiology students. These colleges have different course

*TABLE XII. Demographics of sample.*
*Note: * 2 individuals ID as other + white or other + Middle Eastern. Only 1 student in the N=2510 students in science majors identified as American Indian/Alaskan Native.*

| | % In sample | % In school pop. |
|---|---|---|
| **Asian/Pacific Islander** | 36.6 | 32.0 |
| **Black/African American** | 4.0 | 7.7 |
| **Hispanic** | 25.7 | 23.2 |
| **International/Other *** | 5.0 | 2.0 |
| **Multi-racial/Bi-racial** | 4.0 | 2.8 |
| **White** | 24.8 | 31.4 |
| **Male** | 36 | 42 |
| **Female** | 64 | 58 |
| **Unidentified** | 0 | <1 |
| **1st Yr in School** | 15 | 19 |
| **2** | 15 | 20 |
| **3** | 31 | 25 |
| **4+** | 40 | 35 |
| **Life Science Major** | 73 | 81 |
| **Phys. Science Major** | 14 | 15 |
| **Other Science Major** | 13 | 6 |
| **UNIV- 1st PSE** | 74 | 63 |
| **Other 4yr- 1st PSE** | 8 | 37.25 (only total transfers available |
| **2yr- 1st PSE** | 17 | |
| **Non-immigrant** | 31 | |
| **Immigrant** | 69 | N/A |
| **1.5 gen** | 13 | |

requirements, but also are geographically located in different spaces on campus. This difference in geographical space can influence sense of belonging and desire to engage in campus spaces

(Samura, 2016), and these differences are one of the reasons to narrow the pool of students by removing these students.

Students were recruited for this survey by using multiple methods of announcements. These included direct email solicitations, physical postings on announcement boards, listservs announcements, and classroom announcements. Directory information was used for direct contact emails, and a sample for mailing was selected using a random number generator. A total of N=101 students took the online survey. The overall size of the sample that was sought was a total sample of N=200, with a minimum of N=100. Below this number, inferential statistics will not be valid, and comparisons between groups will not be possible. Still, with some groups, representation was so low among the college, that groups comparisons are cautioned, and so analysis is primarily along major. With the population of these students N= 2510, an N= 125 provides a reasonable sample rate of approximately 5% of the population being studied (Bartlett, Kotrlik & Higgins 2001; Krejcie & Morgan, 1970), and N=100 a reasonable sample size of approximately 4% of the population. Class announcements occurred during the summer and fall semester of 2016, and direct contact through email solicitations sent out in fall of 2016, with volunteers for the qualitative study solicited through the survey. The sample of N=101 science majors that took the survey roughly matched that of the population of students at UNIV, based on data from the office that examined institutional data.

Demographics are outlined above in Table XIII. While racial/ethnic demographics roughly matched that of the population of science majors at the school, it is notable that three students identified as Middle Eastern, a category for inclusion that recently was discussed for inclusion for the 2020 census (NCTREA, 2017). Five international students chose ‘other’ as a racial/ethnic category and indicated their country of origin, again raising concerns about meaning making of terms in survey items.

***Survey design.***

The survey used was a designed survey to examine the effects on factors theorized to influence persistence. This survey drew on survey items from Stanton-Salazar (2001) that have been used examine the academic success of Latinx students. These included social capital among family, peers, and institutional agents. Similar to the items from the NELS 88:00 dataset, these items were constructed with the intent of outlining what resources are accessed through networks with items more explicitly tied to supports, as Stanton Salazar (2001, 2011) outlines social capital as supports from institutional agents or institutional supports. Academic achievement, campus sense of belonging, including racial campus climate, and science identity, were drawn from literature on persistence of students in science as factors influencing persistence in STEM, and were also examined to see if these differences among majors and other groups of students, could explain the different attrition that has been seen in national statistics and in those of UNIV (CDS, 2014; Chang et al., 2011; Hurtado et al., 2011; NSF, 2014).

Items for social capital asked about supports received or accessible supports from peers (both university and outside the university), professors and TA's, counselors, and family. These supports were focused on academic supports, generally and in STEM classes. This was done to prime the connection to succeeding in higher education, as well as specifically in STEM courses as possibly different from succeeding with STEM majors. For family, peers, and counselors, items followed the format: "When it comes to your academics do your... It's important," where the … involved some description of support. The entire survey is attached in Appendix D. Sense of belonging, science identity, and campus racial climate were composites measures previously used in Chang et al. (2011) and Hurtado et al. (2011). Since all have pervious empirical support, internal consistency was examined to validate the measures among this sample.

Additionally, demographics were collected around year in school, racial/ethnic self-identification, gender, immigration status, SES, parental education, initial enrollment in a 2 or 4-year higher education institution and the number of family that were scientists. These demographics have been associated, either directly or indirectly with persistence or academic performance in science (GPA), although often in middle and high school science courses and programs. Additionally, where students considered their close friends to be, frequency of participation in activities that can lead to cultivating supportive social networks were also measured, as the activity and strength of peer interactions on campus have indicated positive or negative effects on academic performance, and campus socialization. Lastly, items were used to measure if students had chosen to attend the university for participation in academic programs, recommendation of family, or because of cost, as these theoretically connect to social capital that existed before they attended the university. In the case of academic programs, this often means various forms of support while at the institution, with many examples showing increases in persistence (Estrada et al., 2017; Oseguera et al., 2008).

**Ridge regression- effects on social capital, academic performance and science identity.**

Separate ridge regression measuring effects on outcomes of social capital among friends, faculty and family, as well as measures of science identity, GPA, and racial campus climate were used, and are described below. Validity concerns are presented after the models.

***Models for social capital, GPA, science identity, and campus racial climate.***

The survey data employed a ridge regression in order to correct for multicollinearity of multiple variables, as multiple items were converted into dummy variables to directly compare effects of group status.

The model for this study used is:

$$\begin{aligned} y_i \mid \mathbf{x}_i &\sim f(y \mid \mathbf{x}_i), \quad i = 1, \dots, n \\ f(y \mid \mathbf{x}) &= \mathrm{n}(y \mid \mathbf{x}^{\top}\boldsymbol{\beta}, \sigma^2) \\ \boldsymbol{\beta} \mid \sigma^2 &\sim \mathrm{N}(\mathbf{0}, (\sigma^2/\widehat{\lambda})\mathbf{I}_p) \\ \widehat{\lambda} &= \text{MMLE of } \lambda \\ \sigma^2 &\sim \mathrm{IG}(\epsilon, \epsilon) \end{aligned}$$

where X is different measures of social capital, science identity, racial climate or GPA, (SSC, SID, RCLIM, GPA), and predictor variables include: major, demographics, higher education status, and reasons for attending institutions. A full listing of variables is in Appendix E. In addition, frequencies for sources of social capital and descriptive statistics will be reported as well as standardized group means for students in life and physical science majors.

***Validity concerns and limitations.***

Cohen's alpha coefficients were used to measure internal consistency among measures for dependent variables, that have previously been found to be measuring for the same underlying factors. Those that were not internally consistent (alpha <.7) were eliminated from analysis. Additionally, the NELS 88:00 analysis indicated that persistence varied due to interaction effects of gender, racial/ethnic background and major, the small cell size among students at UNIV this would produce does not allow for interaction variables. Instead of expanding this analysis quantitatively, semi-structured interviews were used to explore how one group, Latinx students in life and physical science majors, drew on social capital through institutional supports to persist.

**Semi-structured Interviews: Research Question Three**

*What experiences do Latinx students in their 3rd year or beyond in life and physical science students identify as central to persist?*

*What institutional supports were identified as important for persistence, and who did Latinx students draw these from?*

*How are students negotiating home and school networks to access resources to persist?*

This section outlines the data collected from six semi-structured interviews with Latinx life and physical science majors. Students for semi-structured interviews were drawn from the participants that took the survey, and so the institutional setting is the same as it was for UNIV students. Students were interviewed to explore how Latinx students use social capital, as institutional supports, to persist as science majors, or pulled students out of science. Since literature on persistence has suggested that parents, family, and faculty can all act as supports and resources or as detrimental to persistence, how students negotiate these networks provides insight into how they persist in science. The interviews also highlight how participants were making sense of their science identity, climate and sense of belonging in science, framing what institutional supports they saw as appropriate to access, as well as from whom it was appropriate to access from. This section begins with a description of the sample, followed by how the semi-structured interview protocol was individualized for each interview. Then the data analysis approach is outlined.

**Participants for semi-structured interviews.**

Selection criteria for participants was done to examine the experience of a growing higher education population in STEM. Participants for the semi-structured interviews were recruited from class announcements, direct email communication as well as postings in campus buildings, using convenience sampling, and through solicitation at the end of the survey. Since generalizability to a population was not the aim to these interviews, but instead exploration of how students made sense of their experiences science, this was acceptable. Participants were limited to those that identified as Latinx and were in their 3rd year of post-secondary education or beyond. This was done to begin to understand how the social capital of students works to push or pull students out of science majors. The focus on students beyond the second year of study was done as this is the typical point at which most students leave science. In order to make sure that interview participants had survey data attached, they were required to take the survey before they could be interviewed. Since this study was also interested to see if students in different science fields had constructed different understanding in their fields, students were also examined based on whether they were life and physical science majors. Only those students who identified as being in these two fields were recruited. A total of six Latinx students participated in this study. Their demographics and general description are listed below in Table XIV. The six students interviewed consisted of three life and three physical science majors, four women, and two men. The physical science majors were two chemistry students and one earth and environmental student. The life science majors were all biological sciences majors.

Students varied on many dimensions, including how they identified under the 'Latinx' umbrella category. Two of the students were 3rd year students and four were 4th year students, although one student, Eduardo, had previously attended a 2-year college, and left after a semester. He had since reenrolled and was in his 4th year of continuous enrollment in higher education. Eduardo was also the only student to not immediately attend post-secondary education after high school. While students on their surveys all indicated they were

*TABLE XIII. Description of interview participants.*
*Note:* Minors are in [brackets] and arrows → indicate a major had or was in the process of being changed.*

| Pseudonym (yr in school), gender | Major* | Vocational aspirations | Other barriers | Field | Self-identified race/ ethnicity | Scientist family/friends |
|---|---|---|---|---|---|---|
| **Raina (3rd), F** | Chemistry→ Forensic Science (transferring) | Physician (Forensic Pathologist) | Hard of hearing (DRC-no accommodations), Transfer and transferring | Physical | Hispanic or 'whatever,' immigrant id, Guatemalan and Mexican | 0 |
| **Catalina (3rd), F** | Chemistry [Lx Studies]→ Lx Studies [Chemistry] (planned) | Chemistry Teacher | Und. immigrant and parent | Physical | Mexican, Chicana, Immigrant (U) | 0 |
| **Corey (4th), M** | Biology and Env. Sci. → EES | Research (grad school in EES) | Transfer student | Physical | Bi-racial, Puerto Rican, Portuguese, immigrant | 0 |
| **Maria (4th), F** | Biology [Chem., Nutrition] | Chemistry Teacher | Limited vision (DRC-accmds.) | Life | Puerto Rican, Hispanic, immigrant | 2 |
| **Angelica (4th), F** | Biology | Physician (undecided) | immuno thrombo-cytopenia (No DRC) | Life | Spanish (instead of Hispanic), Puerto Rican /Mexican | 0 |
| **Eduardo (4th), M** | Biology and Psychology | Physician (undecided) | Transfer and extended time out of school | Life | American, Hispanic, Mexican | 0 |

Hispanic/Latin@/Chican@, they also varied in how they identified, primarily along nationality of their immigrant parents, and other ways in which they self-identified during interviews were added here. Angelica, who identified as ‘Spanish,’ also did not indicate an immigrant identity on her survey, a position taken by some Puerto Rican people to accentuate their status as US citizens. Still other Puerto Rican people identify as immigrants to highlight the place of birth as the US or the island of Puerto Rico, an identity tied to the politics of Puerto Rican independence (Duany, 2003; Oropesa, 1996). A recent survey also indicates that about half of Latinx immigrants begin to identify as ‘American’ by the third generation, and no longer claiming a Latinx/Hispanic/etc. identity (Lopez, Gonzalez-Barrera, & Lopez, 2017). Only one student had family members or family friends that was a scientist. Lastly, any other challenges that participants raised as challenges to their study were highlighted here, and were all raised during interviews, as these questions were not asked on the survey.

**Data sources and methods.**

A semi-structured interview protocol was developed initially to capture narratives of student’s journey to and through the science ‘pipeline,’ aiming to identify their struggles and what helped them continue. The protocol involved questions that aimed to examine the social capital they used, operationalized as institutional supports (Stanton-Salazar, 2011) to persistence in science fields. Questions were designed based on Stanton-Salazar (2001) and survey results. First, hot the UNIV survey guided the modification of the protocol will be discussed, followed by analysis approach for the interview data.

Survey analysis was used in two ways to modify the semi-structured protocol. First, individual responses were used to modify the interview protocol, and emerging themes from initial analysis also guided questions. was also used in guiding expansion on questions from a standard protocol, with particular focus on seemingly contradictory results. For example, one students’ parents were both science majors, yet had a standardized score (z-score) below the mean for family social capital. In another instance, a student had low racial climate z-score, but high measures of belonging (not used in survey models because $\alpha<.7$). Qualitative research generally provides opportunities to make meaning of data, and issues in how participants make meaning of survey items and terms, and these instances provided direction in how to probe around related questions during the interview, or ask new ones (Park, Buckley, & Koo, 2017).

Additionally, trends began to appear as surveys were collected. Survey participants indicating that close friends were primarily outside of the major in which students belong (over 72%), and more than half-identifying their close friends as being in non-science majors. This suggests that pressures exist within science majors to form peer connections elsewhere, or to form particular types of relationships within the major, as well as to what type of supports are received from peers. Other emerging themes were a lack of family that were scientists among the sample, even though most had parents that had attained some post-secondary degree or certificate, so parents could guide students in some ways to persist, but not with forms of science cultural capital or 'science capital' that helps students engage in science culture and practices (Archer et al., 2015). Seventy-seven percent of participants had no family members that were scientists, although 80% of participants had parents that had some experience with PSE, so suggesting some alignment between home culture and college academic cultures (Tinto, 2012).

Interview methods were used as they allow for a flexible analysis of how individuals are making sense of a phenomenon. They allow for elaboration not possible on surveys, particularly about how they are making sense of their experiences. Rather than be concerned with capturing a post-positivistic 'truth,' this study employs paradigms of naturalism, concerned with how individuals are constructing their social world (Roulston, 2013; Silverman, 2014). Interview questions and analysis were guided by this.

Interview questions were designed with the aim of eliciting description of how students negotiated persistence factors, like family, peers, and faculty/staff, as these interactions have been shown to both promote or deter persistence. Science identification, and campus climate are also important, and have been shown to influence persistence and attrition, as well as socialization into different networks. This was done by asking questions generally about pre-college science experiences, experiences within the college, and specifically about the type of supports they identified as necessary to persist, aiming to identify those institutional supports that they identified, and from who they drew resources from. Individual survey responses were used to ask probing questions around institutional supports received, and from whom. This included asking about interactions and relationships with faculty, and staff, in and out of the classroom, in roles related to undergraduate research, clubs, or programs. Additionally, since Latinx students often must balance home and school networks because of the roles they serve in family, but where family also acts to help students cope with negative experiences on campus.

Questions also began by asking about identified issues associated with student attrition from science majors as well as those factors theorized to influence Latinx persistence in higher education generally. These included asking about campus climate, reasons for attending/studying science, and motivations/vocational aspirations for studying science.

**Data analysis approach.**

Social capital, as conceptualized as institutional supports, was used to analyze interview data. Conceptualizations of social capital through institutional supports (Stanton-Salazar, 2001, 2011) were used as a basis for coding and analysis as these capture the multitude of ways that social ties can help students confront structures of society that stratify society, such as racism, sexism, etc., and overlap with conceptualizations of how science identity is affirmed or disrupted (Carlone & Johnson, 2007). Examining the types of supports students identify to help students persist identified both what resources were needed, but also how they are positioning themselves and their agency to access this support (Carlone & Johnson, 2007; Lin, 1999; Stanton-Salazar, 2011; Stets & Burke, 2000).

Students that have persisted can highlight those institutional supports that have helped counter social structures of oppression as they are experienced by students within different science majors. The structure-agency dialectic highlights the capacity of individuals to transform, reinforce, or dismantle these structures (Giddens, 1979; Sewell, 1992), and social capital captures the multiple ways that students and groups do this, by providing spaces for coping, or for social mobility (Stanton-Salazar, 2001). Decisions to persist, transfer or leave are also captured as responses to social structures, and institutional agents and institutional supports can help facilitate these processes (Bensimon & Dowd, 2012; Dowd, Pak, & Bensimon, 2013), or interfere with affirmation or disruption of their science identity (Carlone & Johnson, 2007; Stets & Burke, 2000).

After verbatim transcription, interview transcripts were coded using a priori constructs of institutional supports, and science identity, as it is theorized that science identity captures agency and position within networks, in relation to forces of social stratification, such as racism, sexism, etc. (Carlone & Johnson, 2007; Garibay 2015, 2017; Lin, 1999; Stanton-Salazar, 2001). Hybrid coding (Saldana, 2014) was then used to align initial coding with the analysis of the quantitative methods employed, and as a way to reduce the data scope (Roulston, 2013; Saldana, 2014). First evaluation coding was used to explore the importance attributed to persistence along institutional supports. Examples of codings are listed below in Table XV. Then, pattern coding was used to identify a subset of themes attributed to persistence by students (Saldana, 2014), with the aim of outlining similar themes among all participants, those in life compared to those in physical sciences, and individual differences.

Negotiation of networks was examined using science identity as an interpretive lens, identifying how dimensions of competence, performance, and recognition (Carlone & Johnson,

*TABLE XIV. Example of codings for types of institutional supports.*

| Code for institutional supports | Quote |
|---|---|
| **Direct** | "…my band director gave me a job here that I needed. He's always been there at least to keep me in the band and give me some work because I need to support myself as well as I can." |
| **Integrative** | "I think almost all the upper level courses, brought in a guest lecturer for one or two, which is nice… from industry representatives and they talked about their work, they talked about they're offering work, you know application of what we were studying at the time." |
| **System Development** | "…the Latino cultural center, the ACCESS bill… I try to be involved as I can… it's just a space for people can the exchange of ideas, and the kind of educating people on ok, if you want to make a difference, it's giving students the medium to make to start, you know a place to start, a place to learn, a place to make mistakes so that way if you want to go out and do this in the real word, you had exposure to like that grassroots organizing." |
| **System Linkage/ Networking Support** | "…my advisor was very real with me and she kind of expressed that she was a general advisor, that she was trained to advise anybody in every field but in every major, and every minor, but if I really wanted specific 4 year plan, I really should go to my major advisor, so kind of her recommendation, and I always do let her look it over, second opinions, it never hurts, you know, and kind of, because my career goals are a little different, because I wasn't pre-health, she wasn't used to it, she just said, you should go see this person, you should go see that person…" |

2007) were reasoned in relation to accessing supports, and from whom. This was particularly important in analyzing resources that were accessed from multiple sources, as well as what sources were avoided. Past literature has noted the struggle URM and women students in STEM have with identity, most notably being pushed to downplay their science or ethnic identity (McGee, 2015), manage identity in ways that hide an aspect of their identity in order to affirm a STEM identity (Settles, 2004), or else fear reinforcing negative stigmas in science about URM students (Beasely & Fischer, 2012; Chang et al., 2011). How they choose to access supports or negotiate which network to align with or withdraw from, indicates their agency to position their identity to align with perceptions of group identity, or resist this group identity (Stets & Burke, 2000). This suggests that ways in which URM student sand women students negotiate their networks within science spaces, and with respect to competence, matters for affirming their belonging within science.

# CHAPTER 4: RESULTS

This chapter outlines the results that answer the three research questions: (a) the first research question using the NELS 88:00 dataset, (b) the second research question using the designed survey given to a sample of UNIV science students, and (c), the third research question using semi-structured interviews. This chapter presents the main findings for each question. First, the analysis of the NELS dataset will be presented, focusing on the exploratory factor analysis, model summaries, significant predictors of persistence related to majors, significant social capital predictors, and other significant predictors of persistence for 1-yr and 2-yr persistence. Then, the results of the analysis of the survey of UNIV science students will be presented. This survey of UNIV students examined six regression models, predicting social capital among family, among friends, and among faculty, as well as science identity, racial climate and GPA. These models are presented as they theoretically predict persistence. Lastly, the results from the semi-structured interviews are presented, presenting findings ow what institutional supports Latinx students in physical and life science majors found as salient to persistence, as well as how they negotiated family, peer and UNIV staff/faculty networks to maximize benefits and minimize detrimental impacts on persistence.

## Research Question One: Evidence from NELS 88:00

The first questions sought to examine whether social capital had an effect on persistence and if this was different across different fields of science. To examine whether social capital items were measuring underlying constructs, an exploratory factor analysis was performed. Then, two different models were run, one without and one with interaction terms, for both 1-yr and 2-yr persistence. These four models were used to examine whether there were differences in persistence across majors, as well as if social capital affected persistence. In addition, this analysis also examined whether race/ethnicity, and gender affected persistence, when social capital was accounted for in the model. The addition of interaction variables for race/ethnicity, gender and major were used to examine particular effects on persistence along these interactions as they related to social capital.

The following section presents the results of these analyses. It is organized by first presenting the results of the exploratory factor analysis, then model summaries for the four models. This is followed by findings of persistence for students in different science fields, the impact of social capital on persistence, and differences along race/ethnicity, as well as other effects related to higher education experiences and educational expectations.

**Exploratory factor analysis.**

An exploratory factor analysis was used to examine the scale items (60 total) measuring for social capital and negative social capital, with others identified by Ream (2005), outlined across four sources of social capital as predicting academic achievement, loaded on underlying factors among the 4-yr college going sample of this study. These included (a) social capital within families labelled as 1, (b) social capital among peers labelled as 2, (b) social capital within the community labelled as 3, and (d) social capital within schools labelled as 4. Further description of domains to these dimensions of social capital are outlined in Chapter 3 (see appendix A for full listing of variables).

A maximum likelihood extraction with a promax rotation (Kappa=4) was used to explore for common loading. Initial analysis extracted 8 factors with eigenvalues greater than 1, which cumulatively accounted for 34% of the variance in the sample. Visual analysis of the scree plot suggested 7 factors and using a more conservative eigenvalue of 2, extracted 5 factors accounting for 30% of the variance. A >.4 factor loading value was used to identify variables with common underlying factors. Chi-Squared analysis ($\chi^2_{(930)}$= 4659.5, p< .0001) would suggest that this analysis is unreliable, but significance was expected, as large N values reduce p values in this case, and chi-squared analyses for goodness of fit is unreliable for large N values. Alternatively, measures of KMO, here KMO=.872, suggests that the data may benefit from variable reduction (Tanaka, 1987). The 5 factors, eigenvalues, and cumulative percentage are presented below in Table XV.

*TABLE XV*. 5 factors after rotation. Promax rotation with Maximum Likelihood extraction.

| | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|
| **Factor** | Total | % of Variance explained | Cum. % | Total | % of Variance explained | Cum.% |
| **1** | 7.909 | 13.181 | 13.181 | 6.892 | 11.486 | 11.486 |
| **2** | 3.82 | 6.366 | 19.547 | 2.98 | 4.967 | 16.452 |
| **3** | 2.826 | 4.71 | 24.257 | 2.476 | 4.127 | 20.579 |
| **4** | 2.469 | 4.115 | 28.372 | 2.17 | 3.616 | 24.196 |
| **5** | 2.253 | 3.755 | 32.128 | 2.225 | 3.708 | 27.903 |
| **6** | 1.9 | 3.166 | 35.294 | 1.254 | 2.09 | 29.993 |

Table XVI outlines these 5 factors. These factors generally aligned with Ream's (2005) categories. Factor 1 aligned with conceptions of social capital within families, along dimensions of parents/siblings being involved in student's education (1a-described in Chapter 3), except for one item, F2P49J, that was part of the parent-student bond category (1b). Except for this item, items from factor 2 aligned with this category of parent-student bond. Factor 3's items aligned with social capital within the community. Still, this had a much narrower community related to social capital, as items that aligned only matched with a religious community. Factor 4 was comprised of items from parent/sibling involvement dimensions of social capital within families (1a), suggesting that this dimension is measuring two unique underlying factors. Items from

*TABLE XVI. Items aligned by factors from NELS items.*

| Factor | Item | Variable | Loadings |
|---|---|---|---|
| **1** | How often PT discuss with teen selecting courses | F2P49A | .688 |
| | How often PT discuss with teen school activities | F2P49B | .657 |
| | How often PT discuss with teen has studies in class | F2P49C | .612 |
| | How often PT discuss with teen their grades | F2P49D | .629 |
| | How often PT discuss with teen about applying to colleges or other schools after HS | F2P49F | .663 |
| | How often PT discuss with teen their special interests or hobbies | F2P49J | .447 |
| **2** | How often attended family functions w/ teen | F2P50F | .44 |
| | How often take day trips or vacation w/ teen | F2P50G | .578 |
| | How often attended. school plays/sports w/ teen | F2P50H | .665 |
| | How often go out to restaurant w/ teen | F2P50J | .698 |
| | How often did something else fun w/ teen | F2P50L | .474 |
| **3** | How often PT attended religious services w child | F2P50E | .705 |
| | How often attend religious services | F2S106 | .961 |
| | How often participated in religious activities | F2S33C | .774 |
| | How often participated in organized religion (f4) | F4IRELIG | .41 |
| **4** | How often PT contacted school about college teen's acad. performance | F2P44A | .407 |
| | How often PT contacted school about teen's acad. Program | F2P44B | .683 |
| | How often PT contacted school about teen's plans after HS | F2P44C | .907 |
| | How often PT contacted school about college prep program | F2P44D | .861 |
| **5** | Among close friends, how important to attend class regularly? | F2S68A | .752 |
| | Among close friends, how important to study? | F2S68B | .771 |
| | Among close friends, how important to get good grades | F2S68D | .775 |
| | Among close friends, how important to continue ed. past HS | F2S68H | .640 |

factor 5 aligned with the dimension of social capital among peers, concerning whether student's friends prioritize education (2c).

Theoretical and previous empirical work, factor 1 clusters items that generally asked about how often parents communicated with their child, connecting the transmittal of norms and knowledge about academics to their children. The second factor was constructed of items asking about involvement parents had with their children in informal, out-of-school activities, except for one school related item associated with extracurricular activities, and related to the bonding within family. The third factor was constructed of times related to attending religious services and activities, indicating bonding with other communities and groups, but with no other items involving outside communities loading on this factor, this suggest that religious activities are independent of other non-school related functions, and outside communities. The fourth factor was constructed of items that asked about parental contact with school concerning their academic performance and plans beyond HS and is indicative of the social capital that parents can draw upon on behalf of students, but this social capital is not always equal between parents (Horvat et al., 2003). The fifth factor was constructed of items examining the academic habits and dispositions of student's close peers, and the common academic practices and norms of students and their peers, but also potentially how compartmentalized academics and other activities are for students.

This analysis suggests that there are indeed underlying constructs measured by these items that are distinct, but also raises questions as to what these underlying constructs are, and how aligned these constructs are if they do not load onto each other but rather distinctly. In the case of social capital, this exploratory factor analysis did little to narrow down the 60 items. This suggests that social capital may be measuring other, multiple underlying constructs, and is a limitation of the data. This is because the NELS 88:00 dataset was not originally constructed to explicitly capture social capital in its measures. This suggests the use of an uninformed prior for the models, and this was employed. A sensitivity analysis indicated that changes in priors did not affect the variance of the models.

**Secondary analysis-models for persistence.**

For 1-year persistence, a model without and one with interactions was used. The original model without interactions used 119 covariates (listed in Appendix A) to predict 1-yr persistence using a binary probit ridge regression. This model did not have interaction terms, and interaction terms for gender, race and major have been suggested in addition to group comparisons to assess the differential persistence among different racial/ethnic groups, and between men and women (Chen, 2013; Ong et al., 2011; Seymour & Hewitt, 1997). The interaction model used 149 covariates to predict persistence. These models were repeated for 2-yr persistence, with and without interaction terms. A sensitivity analysis comparing differences in posterior distribution variance to different prior values (delta values) is listed below in Table XVII. Differences in posterior distribution variance is presented as $R^2$ values based on delta 1 and delta 2 values.

*TABLE XVII. Sensitivity analysis for binary probit ridge regression models by comparing $R^2$ values across different values of priors (delta 1 and delta 2).*

| $\delta_1,\delta_2$ | $R^2$ values, 1-year model | $R^2$ values, 2-year model |
|---|---|---|
| **0,0** | .553 | .817 |
| **0.5, 0.5** | .553 | .817 |
| **1,0.5** | .553 | .817 |
| **0.5,1** | .553 | .817 |
| **1,1** | .553 | .817 |
| **2,2** | .553 | .817 |

***Model statistics.***

Model statistics for the 4 models are listed below in Table XVIII. The 1-yr models accounted for approximately 55% of the variance in 1st year persistence, and the 2-yr models accounted for approximately 82% of the variance in predicting probability of persistence. Model fit data shows that the 1-yr persistence models may be overfit (Gelfand & Ghosh, 1998), while the 2-year model as more parsimonious, and the addition of interaction terms negligibly change the 1-year or 2-year model fit. This suggests that 1-year persistence has a particular set of obstacles based on the transition, while 2-year persistence is more likely a result of effects of social capital.

***Persistence among different majors.***

Whether major affected persistence in these social capital models varied. In the 1-yr model with no interactions, life science majors had increased probability of persistence, while other science and non-science majors had a decreased probability of persistence. When interactions were considered, other and non-science majors still had lower probabilities of persistence, and the propensity score covariate for life sciences was also significant. This meant that there were baseline differences in measures of social capital between life science majors and other majors when interaction terms of race/ethnicity, gender, and major were also considered, but not when these interactions are not added. Interaction terms were significant for male-non-science majors, with increased probability of persistence, and Asian/Pacific Islander (API)-non-science interaction term as well but decreasing probability of persistence. Since non-science major term significant with non-science interaction terms, this suggest a deeper examination of non-science major's persistence along dimensions of race/ethnicity and gender.

*TABLE XVIII. Model fit statistics for NELS 1 and 2-yr persistence models.*

Note: *95% MCCIhw <.1 indicates reasonable convergence of model.

| | 1-year persistence | | 2-year persistence | |
|---|---|---|---|---|
| | | *95% MCCIhw | | 95% MCCIhw |
| **Model posterior predictive SSE** | D(m) = 752.271 | 0.070 | D(m) = 377.787 | 0.093 |
| **Model SSE fit to data** | Gof(m) = 371.369 | 0.025 | Gof(m) = 174.621 | 0.019 |
| **Penalty (predictive variance)** | P(m) = 380.903 | 0.066 | P(m) =203.166 | 0.086 |
| | $R^2$= 0.553 | .000 | $R^2$= 0.817 | .000 |
| | **1 yr w/interactions** | | **2 yr w/interactions** | |
| | | 95% MCCIhw | | 95% MCCIhw |
| **Model posterior predictive SSE** | D(m) = 751.508 | 0.078 | D(m) = 374.616 | 0.086 |
| **Model SSE fit to data** | Gof(m) = 370.637 | 0.024 | Gof(m) = 173.044 | 0.018 |
| **Penalty (predictive variance)** | P(m) = 380.871 | 0.072 | P(m) =201.572 | 0.079 |
| | $R^2$= 0.554 | .000 | $R^2$= 0.819 | .000 |

There was also variation between effects from major in the 2-yr models. In the 2-yr without interaction model, life, physical, and social science majors had higher probability of persistence, while other and non-science majors had lower probability of persistence. Other science propensity score was also significant, indicated baseline differences between other science major persistence and the other four fields of study. When interaction terms were added, non-science majors were the only major that was significantly different and had a lower probability of persistence. Both the life science and other science propensity scores were now significant, indicating baseline differences between these two majors, when race and gender interaction terms were accounted for in the mode. Interaction terms with major field that had increased probability of persistence were Hispanic-life science, API-physical science, Black-social science, API-other science, while API social science majors had a lower probability of persistence. This suggests race/ethnicity or racial climate matters within fields, or that content majors as providing differing pulls into the major, based on field.

***Social capital predictors of persistence.***

This section presents the significant social capital predictors of persistence. These are discussed for 1-yr persistence without and with interactions first, and then for 2-yr persistence without and with interaction terms. The significant predictors for the initial 1-yr persistence model will be presented and the differences when interaction variables are added will then be presented. This will then be repeated for the 2-yr persistence models.

*1-year persistence model without interactions.*

For the model for 1$^{st}$ year persistence with no interactions, total of 16 variables increased probability of persistence, while 21 decreased probability of persistence for social capital along dimensions of Ream (2005), and these are summarized in Table XIX. Eight covariates from Ream's (2005) category of social capital within families were related with increases in the probability of persistence, while 10 covariates decreased probability of persistence. Items that measured whether parents discussed school activities with student, talked to student about applying for college, contacted school about student's academic performance, discussed problems that student have, knew their student's first best friend, contacted the school about doing volunteer work, attended a program related to college financial aid, or influenced the choice of student academic school program, all positively predicted persistence. How well parents knew students were doing in school, how often they discussed what teen has studied in class, whether they contacted the school about students' academic performance, or about student's after high school plans, attended family social functions with teen, spent time doing something fun with teen, discussed teens career plan with other parents, the number of parents of other students at

*TABLE XIX. Parameter estimates for significant predictors of 1st year persistence model, no interactions. Parameter estimates, and 25/75% CI presented. * denotes items that were also significant at 95%CI.*

| | Parameter | Mean | 25% | 75% |
|---|---|---|---|---|
| **1a** | Chose HS program after talking to parents | 0.106 | 0.065 | 0.147 |
| **1a** | PT knows how well teen is doing in school | -0.251 | -0.392 | -0.109 |
| **1a** | How often PT contacted school about college teen's acad. Performance | -0.084 | -0.11 | -0.059 |
| **1a** | How often PT discuss with teen selecting courses | 0.051 | 0.026 | 0.075 |
| **1a** | How often PT discuss with teen school activities | 0.028 | 0.002 | 0.055 |
| **1a** | How often PT discuss with teen has studied in class | -0.043 | -0.069 | -0.018 |
| **1a** | How often PT talked to child about applying for college | 0.034 | 0.013 | 0.056 |
| **1b** | How often discussed things troubling you with PT | -0.025 | -0.048 | -0.003 |
| **1b** | How often PT discuss with teen things that are troubling them | 0.031 | 0.006 | 0.057 |
| **1b** | How often attd family functions w/ teen | -0.03 | -0.053 | -0.007 |
| **1b** | How often did something else fun w/ teen | -0.047 | -0.075 | -0.018 |
| **1b** | Spent time talking or doing things with parents | -0.126 | -0.18 | -0.073 |
| **1c** | PT knows parents of ST 1st friend | 0.093 | 0.031 | 0.156 |
| **1c** | PTs know closest friend's pts. | -0.038 | -0.061 | -0.015 |
| **1c** | # of pts that pt talks to at teen's school | -0.034 | -0.061 | -0.009 |
| **1c** | How often discuss teen's career plans w/ other pts @ teen's school | -0.036 | -0.071 | -0.001 |
| **1d** | PT attd program for Financial aid | 0.068 | 0.021 | 0.116 |
| **1d** | how often PT contacted school about volunteering or help fundraise | 0.066* | 0.043 | 0.09 |
| **1d** | How often attd school plays/sports w/ teen | -0.089* | -0.115 | -0.063 |
| **2a** | How important to have strong friendships | -0.028 | -0.049 | -0.007 |
| **2a** | Changes in the future you will have friends you can count on | 0.029 | 0.008 | 0.05 |
| **2c** | Among close friends, how important to study? | 0.035 | 0.007 | 0.063 |
| **2c** | Among close friends, how important to continue ed past HS | 0.076* | 0.051 | 0.101 |
| **2HE** | Volunteer servicing other students | -0.116 | -0.177 | -0.053 |
| **2HE** | Having or received services from formal tutoring by faculty or students B4 | 0.05 | 0.029 | 0.071 |
| **3 Other** | Registered to Vote | -0.154 | -0.217 | -0.094 |
| **3 Other** | Voted in past election | 0.057 | 0.005 | 0.109 |
| **3a** | How involved PT feels in the community | -0.138 | -0.195 | -0.081 |

| | | | | |
|---|---|---|---|---|
| **3b** | How often participated in religious activities | 0.033 | 0.002 | 0.065 |
| **3b** | How important to help community | -0.035 | -0.057 | -0.013 |
| **3b** | How often attend religious services | -0.035 | -0.069 | -0.003 |
| **3b** | How often PT attended religious services w child | 0.054 | 0.026 | 0.081 |
| **3b** | How often participated in organized religion | -0.094* | -0.117 | -0.071 |
| **3he** | Volunteer servicing the community | -0.13 | -0.185 | -0.076 |
| **3he** | How often of to plays, concerts, museums | 0.037 | 0.017 | 0.058 |
| **3he** | How often participated in organized sports | -0.011 | -0.032 | 0.011 |
| **4 Other** | Outside of school did sports at least 1x week | 0.073 | 0.029 | 0.117 |
| **4b** | Favorite teacher thinks its important for Teen to go to college after HS | -0.064 | -0.109 | -0.017 |
| **4b** | Teacher helped with HW | 0.166* | 0.112 | 0.22 |
| **4b** | How often school contacted PT about students acad. Program | -0.024 | -0.045 | -0.003 |
| **4HE** | Having or received services from formal counseling (personal, academic, financial, or career) | 0.069* | 0.048 | 0.09 |
| **4HE** | Having or received specific instruction in math/reading | 0.002 | -0.018 | 0.022 |
| **4HE** | How often go to public library | -0.031 | -0.051 | -0.011 |
| **Demographics** | life major indicator | 0.145 | 0.012 | 0.279 |
| **Demographics** | other science major | -0.143 | -0.263 | -0.016 |
| **Demographics** | Non science major | -0.31 | -0.422 | -0.197 |
| **Expectations** | Ed expectations college or above (b4) | 0.2 | 0.121 | 0.279 |
| **Expectations** | Expected occupation in science | -0.248 | -0.337 | -0.161 |
| **Expectations** | Expected occupation at 30 is science related | 0.288* | 0.198 | 0.377 |
| **HE Acad** | Had courses in physics | -0.196* | -0.262 | -0.13 |
| **HE Acad** | Had courses in chemistry | -0.092 | -0.151 | -0.032 |
| **HE Acad** | Had courses in Biology | -0.246* | -0.291 | -0.202 |
| **HE Other** | participated in intramural athletics | -0.259* | -0.31 | -0.208 |
| **HE Other** | Participated in Intercollegiate Varsity sports | -0.072 | -0.14 | -0.003 |
| **HE Other** | Participated in social clubs or frats | -0.303* | -0.357 | -0.249 |
| **HE Other** | Intercollegiate Varsity sports | 0.119 | 0.055 | 0.184 |
| **HE-status** | Still enrolled at 1st PSE | -2.155* | -2.208 | -2.101 |
| **HE-status** | Number of institutions attended | -0.253* | -0.276 | -0.231 |
| **HE-status** | enrollment status at 1st PSE (part, half, full time) | -0.025 | -0.04 | -0.01 |
| **Negative** | death in family | 0.057 | 0.016 | 0.099 |
| **Negative** | Ever dropped out (of school at any level) | -0.288 | -0.4 | -0.177 |
| **Negative-HE** | respondent or close friend arrested | 0.085 | 0.035 | 0.136 |
| **Negative-HE** | How often smoke | -0.043 | -0.062 | -0.024 |
| **Negative-HE** | Alcohol consumption | 0.023 | 0.001 | 0.045 |

child's school parent talked to, knew teens closest friends' parents, and parent attending school activities with teen, all reduced probability of 1-yr persistence. Additionally, whether student discussed troubling things with parents, or continued to have contact with parents after high school, also negatively predicted probability of persistence.

Along the dimension of social capital among peers, category 2 of Ream (2005), four covariates increased probability of persistence, while two decreased the probability. Students having friends that they can count on, that think it is important to study, that think it is important to continue education past high school and seeking tutoring from peers (or faculty) all increased the probability of persistence. Student doing things with friends and offering volunteer services to other students decreased probability of persistence.

For social capital within the community (category 3), four covariates positively increased probability of persistence, while seven reduced probability of persistence. Parents attending religious service with their students, attending plays, concerts, or museums, and voting all increased the likelihood of persistence, while parents being involved in the neighborhood, students finding it important to do community work, student attending religious services, religious service participation frequency, and being registered to vote all reduced probability of persistence.

Along social capital within schools, four covariates increased probability of persistence, while three reduced probability of persistence. Teacher having helped students in HS, seeing professional counseling for academic, or other needs, having special instruction in math and reading, and participating in sports (out of school) all improved probability of persistence. School contacting parent about student's academic performance, student's favorite teacher's desire for student after high school being post-secondary education, and frequency of going to public library all reduced probability of persistence.

Lastly, among social capital that is theorized to have negative impacts, three measures were found to increase probability of persistence, while two measures decreased probability of persistence. Having a death of a family member, being or having someone close to them be arrested, and frequency of alcohol consumption all increased probability of persistence. Frequency of smoking, and indicator of ever having dropped out of school, both decreased probability of persistence.

*1-year persistence model with interactions.*

Changes to the persistence model after adding interaction terms for race/ethnicity, gender and major are summarized below. Many of the same covariates continued to be significant, with a total of 18 social capital covariates increasing probability of persistence, while 21 decreased probability of persistence. Significant predictors for this model are summarized in Table XX. This section will indicate changes from significant predictors when interaction terms were added, as well as note any additional significant covariates and those that were no longer significant.

Addition of interaction terms had a different impact on variable groups. For social capital within families, there was no change in significant predictors of persistence. For social capital among peers, student's friends thinking it is important to get good grades was a new significant covariate, decreasing probability of persistence. For social capital within communities, students participating in organized sports, and having voted in past election were no longer significant predictors of persistence. For social capital within schools, receiving special instruction in math or reading was also no longer significant. Lastly, frequency of alcohol consumption was no longer significant.

*TABLE XX. Parameter estimates for significant predictors of 1st year persistence model with interaction terms. Parameter estimates, and 25/75% CI presented. * denotes items that were also significant at 95%CI.*

| | Parameter | Mean | 25% | 75% |
|---|---|---|---|---|
| **1a** | Chose HS program after talking to parents | 0.109 | 0.068 | 0.149 |
| **1a** | PT knows how well teen is doing in school | -0.233 | -0.378 | -0.09 |
| **1a** | How often PT contacted school about college teen's acad. Performance | -0.084 | -0.109 | -0.059 |
| **1a** | How often PT discuss with teen selecting courses | 0.052 | 0.027 | 0.077 |
| **1a** | How often PT discuss with teen has studied in class | 0.028 | 0.002 | 0.054 |
| **1a** | How often PT talked to child about applying for college | 0.034 | 0.012 | 0.056 |
| **1b** | Spent time talking or doing things with parents | -0.129 | -0.182 | -0.076 |
| **1b** | How often discussed things troubling you with PT | -0.025 | -0.048 | -0.002 |
| **1b** | How often PT discuss with teen things that are troubling them | 0.032 | 0.007 | 0.059 |
| **1d** | How often attd. school plays/sports w/ teen* | -0.09 | -0.115 | -0.065 |
| **1b** | How often attd. family functions w/ teen | -0.026 | -0.049 | -0.002 |
| **1b** | How often did something else fun w/ teen | -0.042 | -0.069 | -0.013 |
| **1c** | PT knows parents of ST 1st friend | 0.078 | 0.02 | 0.139 |
| **1c** | PTs know closest friend's pts. | -0.038 | -0.062 | -0.013 |
| **1c** | # of pts that pt. talks to at teen's school | -0.031 | -0.057 | -0.005 |
| **1c** | How often discuss teen' ed. plans w/ other pts @ teen's school | 0.085 | 0.048 | 0.121 |
| **1d** | PT attd. program for Financial aid | 0.07 | 0.024 | 0.117 |
| **1d** | how often PT contacted school about volunteering or help fundraise | 0.066 | 0.043 | 0.09 |
| **2a** | How important to have strong friendships | -0.028 | -0.05 | -0.007 |
| **2a** | Changes in the future you will have friends you can count on | 0.028 | 0.008 | 0.048 |
| **2c** | Among close friends, how important to study? | 0.039 | 0.009 | 0.068 |
| **2c** | Among close friends, how important to get good grades | -0.029 | -0.057 | -0.001 |
| **2c** | Among close friends, how important to continue ed past HS* | 0.076 | 0.052 | 0.1 |
| **2HE** | Volunteer servicing other students | -0.122 | -0.183 | -0.06 |
| **2HE** | Having or received services from formal tutoring by faculty or students B4 | 0.048 | 0.026 | 0.07 |
| **3 Other** | Registered to Vote | -0.165 | -0.227 | -0.1 |
| **3a** | How involved PT feels in the community | -0.148 | -0.205 | -0.092 |
| **3a** | How important to help community | -0.033 | -0.055 | -0.011 |
| **3b** | How often participated in religious activities | 0.034 | 0.005 | 0.064 |
| **3b** | How often attend religious services | -0.035 | -0.068 | -0.003 |

| | | | | |
|---|---|---|---|---|
| **3b** | How often PT attended religious services w child | 0.055 | 0.026 | 0.084 |
| **3b** | How often participated in organized religion | -0.096 | -0.12 | -0.073 |
| **3HE** | Volunteer servicing the community | -0.125 | -0.18 | -0.07 |
| **4 Other** | Outside of school did sports at least 1x week | 0.074 | 0.029 | 0.119 |
| **4b** | Favorite teacher thinks its important for Teen to go to college after HS | -0.077 | -0.124 | -0.028 |
| **4b** | Teacher helped with HW* | 0.158 | 0.104 | 0.213 |
| **4b** | How often school contacted PT about students acad. Program | -0.022 | -0.043 | -0.001 |
| **4HE** | Having or received services from formal counseling (personal, academic, financial, or career) * | 0.075 | 0.054 | 0.096 |
| **Demographics** | other science major | -0.205 | -0.376 | -0.024 |
| **Demographics** | Non-science major | -0.385 | -0.549 | -0.223 |
| **Expectations** | Ed expectations college or above | 0.183 | 0.104 | 0.262 |
| **Expectations** | Expected occupation in science | -0.263 | -0.357 | -0.168 |
| **Expectations** | Expected occupation at 30 is science related* | 0.289 | 0.194 | 0.383 |
| **HE Acad** | Had courses in physics* | -0.2 | -0.268 | -0.13 |
| **HE Acad** | Had courses in chemistry | -0.1 | -0.16 | -0.038 |
| **HE Acad** | Had courses in Biology* | -0.246 | -0.289 | -0.202 |
| **4HE** | How often go to public library | -0.032 | -0.052 | -0.012 |
| **3HE** | How often of to plays, concerts, museums * | 0.044 | 0.022 | 0.065 |
| **HE Other** | Intercollegiate Varsity sports * | 0.1 | 0.035 | 0.164 |
| **HE Other** | participated in intramural athletics | -0.258 | -0.308 | -0.209 |
| **HE Other** | Participated in Intercollegiate Varsity sports | -0.085 | -0.157 | -0.013 |
| **HE Other** | Participated in social clubs or frats* | -0.315 | -0.369 | -0.26 |
| **HE-status** | Number of institutions attended* | -0.26 | -0.282 | -0.237 |
| **HE-status** | enrollment status at 1st PSE (part, half, full time) | -0.027 | -0.041 | -0.012 |
| **HE-status** | Still enrolled at 1st PSE* | -2.178 | -2.234 | -2.12 |
| **Interactions** | male non-science major | -0.132 | -0.258 | -0.002 |
| **Interactions** | A/PI male | 0.178 | 0.026 | 0.329 |
| **Interactions** | Hispanic Male | 0.179 | 0.03 | 0.325 |
| **Interactions** | White male interaction variable | -0.13 | -0.259 | -0.001 |
| **Interactions** | White social science major interaction variable | -0.173 | -0.34 | -0.002 |
| **Interactions** | API non science major interaction variable | -0.219 | -0.388 | -0.054 |
| **Interactions** | Life science major propensity score-1yr persistence | -0.24 | -0.44 | -0.035 |
| **Negative** | respondent or close friend arrested | 0.086 | 0.033 | 0.138 |
| **Negative** | death in family | 0.056 | 0.013 | 0.097 |
| **Negative** | Ever dropped out | -0.298 | -0.408 | -0.188 |
| **Negative-HE** | How often smoke | -0.041 | -0.061 | -0.022 |

*2-year persistence model with no interactions.*

This section presents significant predictors of probability of persistence for the 2-year model without interaction variables. Like the 1-yr model, this section outlines significant social capital predictors by categories form Ream (2005), as well as negative social capital. Results will be presented by dimension of social capital. All significant predictors for this model are summarized in Table XXI.

For social capital along dimensions of Ream (2005), 16 covariates increased and 13 decreased probability of persistence. For social capital within families, nine covariates increased, and seven decreased probability of persistence. Students choosing their program after talking to parents increased probability of persistence. Parents knowing what courses their student is taking, contacting the school about college prep course selection, contacting about student behavior, discussing school activities with student, talking with student about student's grades, working on homework projects with student, talking to teen about applying to college, talking to student about selecting school courses, attending non-school related sports events with teen, going shopping with teen, spending time just talking with teen and knowing teens first friend all time doing something fun with teen, attending school activities with teen all reduced probability of persistence.

For social capital among peers, three covariates increased and two decreased probability of persistence. Importance of student having strong friendships, and their friends thinking it is important to get good grades decreased probability. Having received services in formal tutoring, also improved probability of persistence. Items decreasing probability included siblings helping

*TABLE XXI. Parameter estimates for significant predictors of 2nd year persistence model with no interaction terms. Parameter estimates, and 25/75% CI presented. * denotes items that were also significant at 95%CI.*

| | Parameter | Mean | 25% | 75% |
|---|---|---|---|---|
| **1a** | Chose HS program after talking to parents | 0.098 | 0.04 | 0.156 |
| **1a** | Brother/sister helped w/ HW | -0.116 | -0.186 | -0.044 |
| **1a** | PT knows which courses teen is taking | 0.19 | 0.033 | 0.348 |
| **1a** | PT knows how well teen is doing in school | -0.603 | -0.833 | -0.375 |
| **1a** | How often PT contacted school about college teen's acad. Performance | -0.123 | -0.158 | -0.087 |
| **1a** | How often PT contacted school about teen's acad. Program* | -0.048 | -0.087 | -0.01 |
| **1a** | How often PT contacted school about college prep program | 0.052 | 0.013 | 0.091 |
| **1a** | How often PT contacted school about teen's attd at HS | -0.069 | -0.098 | -0.039 |
| **1a** | How often PT contacted school about child's behavior | 0.06 | 0.029 | 0.09 |
| **1a** | How often PT discuss with teen selecting courses | 0.09 | 0.055 | 0.124 |
| **1a** | How often PT discuss with teen school activities | 0.048 | 0.011 | 0.084 |
| **1a** | How often PT discuss with teen has studies in class | -0.049 | -0.085 | -0.013 |
| **1a** | How often PT discuss with teen their grades | 0.051 | 0.018 | 0.084 |
| **1a** | How often PT discuss with teen about applying to colleges or other schools after HS | -0.045 | -0.079 | -0.011 |
| **1a** | How often work with teen on HW or school projects | 0.075 | 0.043 | 0.107 |
| **1a** | How often PT talked to child about applying for college | 0.087 | 0.057 | 0.119 |
| **1b** | How often PT discuss with teen things that are troubling them* | -0.161 | -0.196 | -0.125 |
| **1b** | How often attd school plays/sports w/ teen | -0.044 | -0.079 | -0.007 |
| **1b** | How often attd plays/concerts/sports w/ teen outside of school | -0.063 | -0.097 | -0.029 |
| **1b** | How often attended sporting events w/teen outside of school | 0.095 | 0.058 | 0.134 |
| **1b** | How often attd family functions w/ teen* | -0.104 | -0.138 | -0.071 |
| **1b** | How often PT went shopping w/teen | 0.046 | 0.014 | 0.08 |
| **1b** | How often PT spent time just talking w/teen | 0.049 | 0.013 | 0.084 |
| **1b** | How often did something else fun w/ teen | -0.068 | -0.107 | -0.028 |
| **1c** | PT knows parents of ST 1st friend | 0.088 | 0.003 | 0.174 |
| **1c** | PT knows parents of ST 2nd friend | -0.079 | -0.156 | -0.002 |
| **1c** | PTs know closest friend's pts. | 0.083 | 0.051 | 0.116 |
| **1c** | How often discuss things @ teen's school w/ other pts | 0.044 | 0.003 | 0.087 |
| **1d** | PT attd program for Financial aid* | 0.29 | 0.227 | 0.356 |
| **2a** | How important to have strong friendships | -0.03 | -0.059 | -0.001 |
| **2c** | Among close friends, how important to attend class regularly? | 0.058 | 0.02 | 0.095 |
| **2c** | Among close friends, how important to get good grades | -0.051 | -0.091 | -0.011 |
| **2c** | Among close friends, how important to continue ed past HS | 0.061 | 0.026 | 0.096 |
| **2HE** | Having or received services from formal tutoring by faculty or students B4 | 0.048 | 0.017 | 0.079 |
| **3a** | Community volunteer in past 2 years | 0.122 | 0.063 | 0.181 |

| | | | | |
|---|---|---|---|---|
| **3a** | How involved PT feels in the community | -0.181 | -0.262 | -0.103 |
| **3a** | How important to help community | -0.075 | -0.106 | -0.044 |
| **3a** | How safe is neighborhood | 0.067 | 0.039 | 0.095 |
| **3b** | How often participated in religious activities | -0.047 | -0.089 | -0.005 |
| **3b** | How often attend religious services | 0.059 | 0.014 | 0.103 |
| **3b** | How often PT attended religious services w child | 0.07 | 0.03 | 0.11 |
| **3b** | How often participated in organized religion * | -0.184 | -0.217 | -0.149 |
| **3HE** | Volunteered at civic or community center in past yr | 0.156 | 0.092 | 0.222 |
| **3n** | Registered to Vote | -0.199 | -0.289 | -0.105 |
| **4 Other** | Outside of school did sports at least 1x week | 0.137 | 0.077 | 0.197 |
| **4b** | Favorite teacher thinks its important for Teen to go to college after HS* | 0.198 | 0.135 | 0.263 |
| **4b** | Teacher helped with HW | 0.094 | 0.02 | 0.17 |
| **4b** | How often school contacted PT about students acad. Program | 0.051 | 0.022 | 0.082 |
| **Demographics** | Life major indicator | 0.244 | 0.053 | 0.434 |
| **Demographics** | physical science major | 0.424 | 0.215 | 0.634 |
| **Demographics** | social science major | 0.197 | 0.02 | 0.367 |
| **Demographics** | Other science major indicator | -0.198 | -0.381 | -0.017 |
| **Demographics** | R/E-Hispanic | -0.217 | -0.402 | -0.028 |
| **Demographics** | Non science major | -0.198 | -0.368 | -0.031 |
| **Demographics** | Male | 0.076 | 0.005 | 0.147 |
| **Expectations** | Ed expectations college or above * | 0.45 | 0.318 | 0.582 |
| **Expectations** | Expected occupation in science | -0.333 | -0.471 | -0.195 |
| **Expectations** | Expected occupation at 30 is science related* | 0.422 | 0.282 | 0.56 |
| **HE ACAD** | Had courses in physics | -0.185 | -0.276 | -0.095 |
| **HE ACAD** | Had courses in chemistry | -0.107 | -0.189 | -0.025 |
| **HE ACAD** | Had courses in Biology* | -0.34 | -0.401 | -0.277 |
| **HE Other** | Intercollegiate Varsity sports * | 0.221 | 0.133 | 0.313 |
| **HE Other** | participated in intramural athletics | -0.319 | -0.386 | -0.252 |
| **HE Other** | Participated in social clubs or frats | -0.166 | -0.236 | -0.095 |
| **HE-Status** | Still enrolled at 1st PSE* | -4.558 | -4.674 | -4.436 |
| **HE-Status** | Number of institutions attended* | 0.296 | 0.268 | 0.324 |
| **HE-Status** | enrollment status at 1st PSE (part, half, full time)* | 0.117 | 0.099 | 0.136 |
| **Negative** | Family became seriously ill or disabled | -0.095 | -0.164 | -0.024 |
| **Negative** | Family or respondent ever been a victim of a crime | -0.211 | -0.313 | -0.111 |
| **Negative** | Ever dropped out | -0.266 | -0.441 | -0.09 |
| **Negative -HE** | How often smoke * | -0.142 | -0.17 | -0.113 |
| **Propensity Covariate** | Other science major propensity score-2yr persistence | 0.691 | 0.389 | 0.986 |

with student's homework. Similarly, parents working on homework projects with teen, parents contacting school about students' academic performance, academic program, or student attendance, parent talking to student about applying to school after HS, discussing troubling things with student, attending family functions with teen, knowing students 2nd friend, having friends think it is important to attend class, and friends that think it is important to continue education past HS, and increased probability of persistence.

For social capital with the community, five covariates increased and five decreased probability of persistence. Student volunteering in the community, how often student participated in religious activities, student attending religious services, and volunteering in a civic or community center all increased probability of persistence. Parents believing that the neighborhood is safe, and parents attending religious service with student also increased probability of persistence, while parents being involved in the neighborhood decreased probability of persistence. Student feeling it is important to help others in the community, participating in out of school sports, and frequency of religious participation also decreased probability of persistence.

For social capital within schools, all four significant variables positively predicted persistence. These were teacher helping student with homework, favorite teachers' desire for student after HS is PSE, how often school contacted parents about student academic program, and participation of sports outside of school.

Lastly, negative social capital, three decreased probability of persistence, and none increased probability of persistence. Frequency of smoking, if a student ever dropped out of school at any grade, and if student or someone close was arrested of a crime or ever fell ill, all decreased probability of persistence.

*2-year persistence model with interactions.*

Differences from the results of the initial model are described in this section. Significant predictors for this model are summarized in Table XXII. There were a few changes in terms of social capital with the addition of interaction variables, as was the case in the 1-yr models.

For social capital along dimensions of Ream (2005), 26 covariates positively predicted probability of persistence, while 21 negatively predicated persistence. For social capital within families, significant covariates of parents knowing parents of teens first friend and parent attending school activities with teen were no longer significant. Teens spending time talking or doing things with friends was now significant, decreasing probability of persistence. For social capital among peers, all significant predictors from the original model were significant, and two others, using networking to get a job, and the changes in the future that you will have friends you can count on, both now reduced probability of persistence. For social capital within communities all of the same covariates remained significant and there were no new significant covariates. For social capital within schools, teacher helping student with HW was no longer significant. Lastly, for negative social capital covariates remained unchanged.

***Other predictors of persistence.***

This section outlines significant predictors that were not defined as social capital or major field of study. This includes race/ethnicity, gender, educational expectations as well as and higher education status. These will be presented across the four models.

*TABLE XXII. Parameter estimates for significant predictors of 2$^{nd}$ year persistence model with interaction terms. Parameter estimates, and 25/75% CI presented. * denotes items that were also significant at 95%CI.*

| | Parameter | Mean | 25% | 75% |
|---|---|---|---|---|
| **1a** | Chose HS program after talking to parents | 0.101 | 0.044 | 0.158 |

| | | | | |
|---|---|---|---|---|
| **1a** | Brother/sister helped w/ HW | -0.146 | -0.216 | -0.077 |
| **1a** | PT knows which courses teen is taking | 0.167 | 0.004 | 0.331 |
| **1a** | PT knows how well teen is doing in school | -0.619 | -0.845 | -0.386 |
| **1a** | How often PT contacted school about college teen's acad. performance* | -0.127 | -0.162 | -0.091 |
| **1a** | How often PT contacted school about teen's acad. program | -0.06 | -0.1 | -0.02 |
| **1a** | How often PT contacted school about college prep program | 0.063 | 0.023 | 0.104 |
| **1a** | How often PT contacted school about teen's attd at HS | -0.073 | -0.103 | -0.043 |
| **1a** | How often PT contacted school about child's behavior | 0.079 | 0.048 | 0.11 |
| **1a** | How often PT discuss with teen selecting courses | 0.096 | 0.059 | 0.131 |
| **1a** | How often PT discuss with teen school activities | 0.045 | 0.007 | 0.082 |
| **1a** | How often PT discuss with teen has studies in class | -0.063 | -0.098 | -0.028 |
| **1a** | How often PT discuss with teen their grades | 0.044 | 0.01 | 0.078 |
| **1a** | How often PT discuss with teen about applying to colleges or other schools after HS | -0.045 | -0.08 | -0.01 |
| **1a** | How often work with teen on HW or school projects | 0.079 | 0.047 | 0.112 |
| **1a** | How often PT talked to child about applying for college | 0.093 | 0.061 | 0.126 |
| **1b** | How often PT discuss with teen things that are troubling them* | -0.166 | -0.201 | -0.129 |
| **1b** | How often attd plays/concerts/sports w/ teen outside of school | -0.068 | -0.102 | -0.034 |
| **1b** | How often attended sporting events w/teen outside of school | 0.088 | 0.051 | 0.126 |
| **1b** | How often attd family functions w/ teen | -0.091 | -0.123 | -0.057 |
| **1b** | How often PT went shopping w/teen | 0.036 | 0.002 | 0.069 |
| **1b** | How often PT spent time just talking w/teen | 0.045 | 0.008 | 0.081 |
| **1b** | How often did something else fun w/ teen | -0.063 | -0.101 | -0.024 |
| **1b** | Spent time talking or doing things with parents | -0.097 | -0.174 | -0.019 |
| **1c** | PT knows parents of ST 2nd friend | -0.104 | -0.181 | -0.026 |
| **1c** | PTs know closest friend's pts. | 0.086 | 0.052 | 0.12 |
| **1c** | How often discuss things @ teen's school w/ other pts/ | 0.05 | 0.007 | 0.091 |
| **1d** | PT attd program for Financial aid* | 0.303 | 0.238 | 0.368 |
| **2 Other** | Used networking to get current job | -0.064 | -0.121 | -0.007 |
| **2a** | Changes in the future you will have friends you can count on | -0.031 | -0.06 | -0.001 |
| **2c** | Among close friends, how important to attend class regularly? | 0.066 | 0.027 | 0.103 |
| **2c** | Among close friends, how important to get good grades | -0.058 | -0.097 | -0.019 |
| **2c** | Among close friends, how important to continue ed past HS | 0.057 | 0.022 | 0.092 |
| **2HE** | Having or received services from formal tutoring by faculty or students B4 | 0.05 | 0.02 | 0.079 |
| **3 HE** | Volunteered at civic or community center in past yr | 0.144 | 0.075 | 0.213 |
| **3 Other** | Registered to Vote | -0.2 | -0.29 | -0.11 |
| **3a** | Community volunteer in past 2 years | 0.107 | 0.042 | 0.175 |
| **3a** | How involved PT feels in the community | -0.197 | -0.278 | -0.115 |
| **3a** | How important to help community | -0.072 | -0.103 | -0.04 |

| | | | | |
|---|---|---|---|---|
| **3a** | How safe is neighborhood | 0.071 | 0.042 | 0.1 |
| **3b** | How often participated in religious activities | -0.049 | -0.091 | -0.008 |
| **3b** | How often attend religious services | 0.058 | 0.012 | 0.103 |
| **3b** | How often PT attended religious services w child | 0.076 | 0.037 | 0.116 |
| **3b** | How often participated in organized religion * | -0.193 | -0.227 | -0.158 |
| **4 Other** | Outside of school did sports at least 1x week | 0.151 | 0.089 | 0.212 |
| **4b** | Favorite teacher thinks its important for Teen to go to college after HS | 0.179 | 0.112 | 0.245 |
| **4b** | How often school contacted PT about students acad. Program | 0.053 | 0.023 | 0.083 |
| **Demographics** | R/E-Hispanic | -0.384 | -0.653 | -0.115 |
| **Demographics** | Non-science major | -0.298 | -0.538 | -0.047 |
| **Expectations** | Ed expectations college or above * | 0.44 | 0.297 | 0.578 |
| **Expectations** | Expected occupation in science | -0.363 | -0.506 | -0.225 |
| **Expectations** | Expected occupation at 30 is science related | 0.409 | 0.266 | 0.549 |
| **HE Acad** | Had courses in physics | -0.175 | -0.268 | -0.082 |
| **HE Acad** | Had courses in chemistry | -0.115 | -0.202 | -0.025 |
| **HE Acad** | Had courses in Biology* | -0.353 | -0.417 | -0.287 |
| **HE Other** | Intercollegiate Varsity sports | 0.186 | 0.1 | 0.275 |
| **HE Other** | participated in intramural athletics * | -0.319 | -0.386 | -0.251 |
| **HE Other** | Participated in social clubs or frats | -0.175 | -0.245 | -0.105 |
| **HE-Status** | Still enrolled at 1st PSE* | -4.651 | -4.765 | -4.533 |
| **HE-Status** | Number of institutions attended* | 0.296 | 0.267 | 0.326 |
| **HE-Status** | enrollment status at 1st PSE (part, half, full time)* | 0.12 | 0.1 | 0.139 |
| **Interactions** | male physical science major | 0.292 | 0.003 | 0.588 |
| **Interactions** | A/PI male | 0.323 | 0.098 | 0.541 |
| **Interactions** | Hisp. life science major | 0.378 | 0.067 | 0.689 |
| **Interactions** | Hispanic Male | 0.397 | 0.175 | 0.612 |
| **Interactions** | Black Male | -0.362 | -0.591 | -0.127 |
| **Interactions** | A/PI physical science major | 0.437 | 0.077 | 0.796 |
| **Interactions** | A/PI social science major | -0.353 | -0.63 | -0.069 |
| **Interactions** | Black social science major | 0.594 | 0.278 | 0.9 |
| **Interactions** | A/PI other science major | 0.316 | 0.003 | 0.639 |
| **Negative** | Family became seriously ill or disabled | -0.086 | -0.152 | -0.017 |
| **Negative** | Family or respondent ever been a victim of a crime | -0.247 | -0.35 | -0.143 |
| **Negative** | Ever dropped out | -0.273 | -0.449 | -0.101 |
| **Negative-HE** | How often smoke * | -0.143 | -0.172 | -0.114 |
| **Propensity Covariate** | Life science major propensity score-2yr persistence | -0.375 | -0.689 | -0.071 |
| **Propensity Covariate** | Other science major propensity score-2yr persistence | 0.657 | 0.345 | 0.959 |

*Race/ethnicity, gender and interactions effect on persistence.*

This section outlines the impact of race/ethnicity, gender and interaction effects. For the 1-yr no interactions model, no race/ethnicity or gender terms were significant. When interactions were added, there were no main effects, but three significant interaction predictors. For 2-yr persistence, there were two significant predictors. When interaction effects were added, one main effect term and three interaction variables were significant.

One-year and 2-yr persistence models differed on main effects and interaction variable. In the 1-yr persistence models, there were no main effects significant in either model, with or without interactions. Significant interaction terms with Asian/ Pacific Islander-male, Latinx-male as positive, and White-male as negative. In the 2-yr model with no interaction, being male increased probability, and being Latinx decreased probability of persistence. When interaction terms are added, male is no longer significant, while Latinx term continues to negatively predict probability of persistence for main effects. Interaction terms for Asian/Pacific Islander-male, and Latinx-male positively predicted probability for persistence, while Black-male interaction terms, decreased probability of persistence.

*Higher education experiences and status.*

Items from higher education experiences that did not theoretically align with those of Ream (2005) are presented in this section. These included coursework in science, participation in extracurricular activities, and higher education status. Significant covariates will be presented by 1-yr model and 2-yr models, as they had the same significant covariates.

For 1-yr persistence models, one higher education covariates increased probability of persistence while eight reduced probability of persistence. For items for educational status two covariates were significant and both negatively predicted probability of persistence. These were still being enrolled in their original post-secondary institution and being full status over part-time or half-time. Coursework in science (biology, chemistry, physics), participating in intra-school/mural athletics, social clubs, or student government all also reduced probability of persistence. Participation in varsity athletics lead to an increase in probability of persistence.

In the 2-yr persistence models, one higher education covariates increased probability of persistence while eight reduced probability of persistence. The number of institutions attended and being full status over part-time or half-time, increased probability of persistence, while being enrolled in the original postsecondary institution decreased probability of persistence. Participation in varsity athletic sports increased probability of persistence, while taking coursework in biology, chemistry or physics, participating in intraschool athletics, or social clubs all decreased probability of persistence.

*Educational expectations and persistence*

Educational expectations were the most consistent variables across all models, as all three predictors were significant and predicted probability in the same direction for all models. Expecting to have a science occupation at age 30 and expecting to have education of college or beyond as an 8$^{th}$ grader, positively predicted probability of persistence, while expecting to have a job in science negatively predicted probability of persistence.

**Research Questions Two and Three: Survey and Interview Data on UNIV Campus**

This section outlines the analysis of data from the mixed, study on campus. This section explored whether students in different science fields (life/physical/other) differed on measures theorized to impact persistence. These included social capital among family, peers, and faculty, as well as science identity, academic performance, and campus racial climate. This analysis was conducted using a ridge regression of survey data. Then, the analysis of semi-structured interviews was used to answer what institutional supports do Latinx students in life and physical science majors identify as key to persistence, and how they negotiated their networks to access resources to persist. This section begins by presenting findings from the survey that answer research questions two, from the analysis of the ridge regression models used. This is followed by a presentation of data from the semi-structured interviews that answers research question three. Common supports and themes are presented from this interview data.

**Designed survey.**

The survey of UNIV science students examined factors that predicted six theorized predictors of persistence. These were social capital among family, peers, and faculty, as well as academic performance, campus racial climate, and science identity. GSS and sense of belonging were not internally consistent measures ($\alpha < .70$), and so regression was performed for these measures. A more detailed description of items is outlined in Chapter 3 and in Appendix A. This section begins by presenting descriptive statistics for the sample, followed by the significant predictors for the models that were significant.

***Frequencies and descriptive statistics.***

This section outlines frequencies and descriptive statistics for the UNIV survey analysis. First frequencies for sauces of social capital among the UNIV sample will be presented, followed by descriptive statistics for the outcome variables of the six models. The six models predicted GPA, science identity, racial campus climate, and social capital among family, peers, and faculty.

Sample frequencies for sources social capital are listed below in Table XXIII. Measures of science capital, or cultural capital of science is connected to past exposure or experiences in the culture of science, and from family members as prime sources of science norms or knowledge of science practices (Archer, DeWitt, Osborne, Dillon, Willis, & Wong, 2012). Still, this sample had more than 77% of respondents indicate that they had no family or family friends that were scientists. Parental education is also seen as a source of social capital, as they can help their children navigate the college going process, if not the science cultural capital in higher education. Over 60% of the sample have parents with some sort of college degree or certificate, and over 50% have a four-year degree or beyond, starkly different from the rates of science family members. Lastly, more than 19% of students identified their close friends as being within their major, although over 71% identified their friends to be in their science major or another science major, and less than 20% identified their close friends to be outside of the university.

Descriptive statistics for the dependent/outcome variables are outlined below in XXIV. GPA was not a multi-item construct and so has no measure for internal consistency. Science identity was initially a 4-item construct from Chang et al. (2011, 2014), loosely aligned theoretically to dimensions of Carlone & Johnson's (2007) science identity. This was reduced to three items as one was exclusively related to biomedical sciences and so not related to physical and other science fields. Campus racial climate was also a construct from Chang et al. (2011) and were not modified. Family, peer and faculty social capital were items generally constructed along items of Stanton-Salazar (2001) and were modified to fit the higher education environment.

Since this study was concerned with the persistence of Latinx students in different majors group means for life and physical science majors are also presented. It should be noted though, that only for the outcome variable of GPA was Latinx racial/ethnicity predictor significant, while major and gender items were not. Cell sizes for some groups were also too small to use interaction variables as covariates, specifically that of male physical science majors, which had

*TABLE XXIII. Frequencies for sources of social capital in UNIV sample.*

*Note: All variables are dummy variables.*

| | Value | N | % of sample |
|---|---|---|---|
| **Family or family friends who were scientists** | 0 | 78 | 77 |
| | 1 | 5 | 5 |
| | 2 | 13 | 13 |
| | 3 or more | 5 | 5 |
| **Close friends are in…** | Not at UNIV | 20 | 20 |
| | in my major | 19 | 10 |
| | in non-science major | 9 | 9 |
| | in science major other than mine | 53 | 52 |
| **Parents highest level of education** | 2-year college degree | 9 | 9 |
| | 4-year college degree | 27 | 27 |
| | high school degree | 20 | 20 |
| | less than high school degree | 0 | 0 |
| | Graduate or Professional degree | 25 | 25 |
| | Vocational/Technical Degree/cert. | 20 | 20 |

an N=3, and male Latinx physical science majors, that were an N=2, with a cell size of a minimum of 5 often recommended for these comparisons, with a minimum of 7 affording reasonable means for comparison (Kraemer & Thiemann, 1987; Wilson VanVoorhis & Morgan, 2007), these were also not reported as means, since the small N would have yielded little insight.

Table XXIV outlines the descriptive statistics for the outcome variables, and Table XXV outlines standardized group means (except for GPA) for life and physical science majors. Of note for the descriptive statistics is the relatively large range, given the standard deviation of 0.46, as this indicates a relatively large number of students near a GPA of 2, as the upper bound for GPA is 4, less than 2 standard deviations above the mean. Among the group means, physical science majors have lower peer social capital than life science majors, but higher family and family social capital, as well as GPA, and science identity.

*TABLE XXIV. Descriptive statistics for UNIV models*

| | Range | Mean | SD | SE | α | |
|---|---|---|---|---|---|---|
| **Family Social capital (academic)** | 14 | 12.68 | 3.03 | 0.30 | .704 | 4 items |
| **Peer Social capital at UNIV (academic)** | 14 | 14.59 | 2.899 | 0.29 | .723 | 4items |
| **Faculty Social capital (academic)** | 12 | 9.42 | 2.228 | 0.22 | .723 | 3 items |
| **Campus Racial Climate** | 20 | 22.25 | 3.7294 | 0.37 | .906 | 5 items |
| **Science Identity** | 11 | 11.59 | 2.155 | 0.21 | .720 | 3 items |
| **GPA** | 2 | 3.38 | 0.460 | 0.05 | | self-reported |

*TABLE XXV. Group means for life and physical science majors on six outcome variables. Note: All scores are standard scores except for GPA.*

| | Life | Phys |
|---|---|---|
| **GPA** | 3.43 | 3.36 |
| **Peer Social capital at UNIV (academic)** | 0.025 | -0.292 |
| **Family Social capital (academic)** | -0.010 | 0.064 |
| **Faculty Social capital (academic)** | -0.081 | 0.320 |
| **Campus Racial Climate** | -0.051 | 0.168 |
| **Science Identity** | -0.011 | 0.189 |

***Ridge regression models.***

Ridge regression was used to correct for multicollinearity of items in predicting differences in social capital and other predictors of persistence. The primary aim was to see if major fields of study were significant predictors for outcomes, as this would suggest differences in measures that could explain attrition from different fields. In addition to major, covariates included race/ethnicity, gender, parental education, identification as an immigrant, ease of contact with family, 1st post-secondary education institution, language preference, family members that are scientists, location of close friends, academic year, SES, and importance of cost, academic programs, family recommendations and closeness to home for reason for choosing UNIV. A full list of the 48 covariates as predictors are listed in Appendix E.

Model fit statistics for the six models are outlined below in Table XXVI. Model fit statistics indicate both if models are significant and how close the data the regression curves were fit. Here, $R^2$ values indicate the percentage of the variance in the outcomes explained, and values of 0 show that the model does not explain variation in the outcome, and these models are not significant. These models were for science identity, racial climate, and faculty social capital. Significant were for predicting social capital family, social capital from peers, and GPA. These models explained between 21 to 31% of the variance in the outcome measures.

*TABLE XXVI. Model fit statistics for six models.*

| | Science Identity | Racial Climate | GPA | Social capital Faculty | Social capital Peer | Social capital Family |
|---|---|---|---|---|---|---|
| **D(m)** | 199.696 | 188.916 | 142.119 | 203.367 | 151.906 | 161.157 |
| **Gof(m)** | 98.849 | 93.507 | 65.173 | 100.667 | 69.650 | 75.714 |
| **p(m)** | 100.847 | 95.410 | 76.946 | 102.701 | 82.255 | 85.442 |
| **$r^2$** | .000 | .000 | 0.314 | .000 | 0.309 | 0.215 |

***Results.***

Analysis yielded significant models for predicting social capital from family, social capital from peers, and GPA. Significant predictors for each outcome variable is outlined in Table XXVII. Significant variables were identified using the posterior probability that the standardized coefficient is within 1 standard deviation of zero, using 75% confidence interval and are listed below. For predicting academic success as measured by GPA, significant positive covariates included gender, identifying close friends as not being in the university, and the degree to which academic programs and low-cost influences decisions to attend UNIV. Negative

*TABLE XXVII. Significant covariates for UNIV survey models.*

*Note: Identified using the 75% CI. * indicates 95%CI.*

| Model | Covariate | beta | 25% | 75% | PP1SD |
|---|---|---|---|---|---|
| **GPA** | Female | 0.068 | 0.031 | 0.105 | 0.394 |
| | Hispanic Ethnicity (Latinx) | -0.072 | -0.110 | -0.034 | 0.379 |
| | Close friends not at UNIV. | 0.055 | 0.018 | 0.093 | 0.477 |
| | Reason went to UNIV for acad. Program | 0.058 | 0.022 | 0.095 | 0.447 |
| | Reason went to UNIV for low cost | 0.100 | 0.063 | 0.136 | 0.199 |
| | Reason went to UNIV- family recommendation | -0.062 | -0.099 | -0.025 | 0.432 |
| | Reason went to UNIV- close to home | -0.067 | -0.104 | -0.030 | 0.398 |
| **Peer Social Capital** | Female | 0.062 | 0.024 | 0.101 | 0.443 |
| | Prefer Foreign language | -0.055 | -0.093 | -0.017 | 0.482 |
| | Close friends not at UNIV. | -0.071 | -0.110 | -0.032 | 0.394 |
| | Reason went to UNIV for acad. Program | 0.127* | 0.0.089 | 0.164 | 0.102 |
| | Reason went to UNIV- family recommendation | 0.088 | 0.050 | 0.127 | 0.286 |
| | Reason went to UNIV- close to home | 0.063 | 0.024 | 0.101 | 0.439 |
| **Family Social capital** | Reason went to UNIV- family recommendation | 0.075 | 0.044 | 0.107 | 0.260 |
| | Reason went to UNIV- close to home | 0.045 | 0.013 | 0.076 | 0.486 |

covariates included Latinx race/ethnicity, and the importance family recommendation, and need to stay close to home was in deciding to attend UNIV. Peer social capital was positively predicted by female gender, and importance of academic programs, family recommendations and desire to stay close to home as reasons to attend UNIV. Preferring to speak a foreign language and having close friends not at UNIV, negatively affecting peer social capital. For family social capital, there were only two significant predictors, both positive, and they were the importance of family recommendations and desire to stay close to home.

**Semi-structured interviews.**

Semi-structured interview data answered the third research question. Six students that identified as Latinx and also identified as being within a life or physical science major were interviewed and their transcripts examined using a hybrid coding scheme. These students were recruited in various ways, including classroom announcements, email solicitations, or reference from an institutional agent that suggested they participate. The intent of analyzing the interview data was to examine which institutional supports were identified as key for persistence, while also examining how science identity, framed the networks they sought to engage in and their use of institutional supports they used to persist. An outline of their year in school, major, vocational aspirations, measures on outcomes predicting persistence, and potential sources of social capital are outlined in Table XXVIII.

The institutional supports identified as key to persistence were expressed at different rates by participants after initial coding. The four types of institutional supports from Stanton-Salazar (2011), direct, integrative, system development and system linkage/network development each offer a different resource with which participants used to navigate structural inequalities to persist. Direct institutional supports, resources immediately usable by students, were most often

*Table XXVIII. Semi-structured interview participants.*

Note: For major, minors are indicated in brackets, and arrows indicate the change into a new major, or planned change. Z-scores are standard scores, standardized across UNIV science student participants from the survey.

| Pseudonym (Yr in School) | Major [minor]→ switched | Vocational aspirations | Z-Science ID | GPA (**zGPA**) | Z-SOCAP FAM | Parents' Education | Other Family | Z-SOCAP UNIV PEERS | Where are close friends? | Z-SOCAP FAC | Z- RACIAL Climate, (Race/eth, immigrant status) | Other barriers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Maria (3rd)** | Biology [Chem., Nutrition] | Chemistry Teacher | 0.188 | 3.45 (0.151) | -0.225 | Parents have BS in CS | None | 0.402 | IN OTHER SCI MAJOR | 0.524 | -0.068 (Puerto-Rican, 2nd gen immigrant) | Limited vision (DRC-accmds.) |
| **Catalina (3rd)** | Chemistry [Lx Studies]→ Lx Studies [Chemistry] (planned) | Chemistry Teacher | -0.740 | 3.1 (-0.612) | -0.556 | Less than HS | Older brother, younger sister | 0.283 | OUTSIDE UNIV | 0.381 | 0.468 (Mexican/ Chicana, 1.5 gen immigrant) | Und. immigrant parent |
| **Raina (3rd)** | Chemistry→ Forensic Science | Physician (Forensic Pathologist) | -0.276 | 3.5 (0.260 ) | 1.090 | Mom dropped out of college (Business) | Twin sister and younger brother | 0.331 | OUTSIDE UNIV | 0.572 | 0.740 (Mexican/ Guatemalan, 2nd gen immigrant) | Hard of hearing (DRC-no accmds.), Transfer and transferring |
| **Corey (4th)** | Biology/Env Sci→ EES | Research (grad school in EES) | -0.740 | 3.6 (0.478) | -0.555 | Dad-VoTec, Mom- cert. (in progress) | Older brother, younger sister, many cousins | 0.378 | IN OTHER NON-SCI MAJOR | 0.477 | -0.872 (Biracial- Puerto Rican/ White, non-immigrant) | Transfer student |
| **Angelica (4th)** | Biology | Physician (undecided) | 0.652 | 2.9 (-1.049) | 0.435 | Mom-2yr accounting degree; no presence of dad | Brother, cousin ('sister) | 0.402 | IN OTHER SCI MAJOR | 0.334 | -0.872 ("Spanish," Puerto-Rican/ Mexican, non-immigrant) | immune thrombo-cytopenia (No DRC) |
| **Eduardo (4th)** | Biology and Psychology | Physician (undecided) | -1.204 | 3.78 (0.872) | -0.885 | No formal ES | Older brother | 0.331 | OUTSIDE UNIV | 0.524 | -0.872 (American/ Hispanic, 2nd gen immigrant) | Transfer and time out of school |

mentioned. Direct institutional supports were resources like housing, or undergraduate work-study opportunities, or knowledge, advice, tutoring, or advocacy. Integrative was the second most common institutional support raised. Integrative supports, institutional supports that helps students navigate integration into higher education, or science majors. This integrative support captures such resources as guidance to science spaces on campus or more broadly or is manifested through direct mentoring. System linkage linkage/network development supports are those where networks are leveraged by others to help participants connect with others who have access to the resources needed. This support can also be active recruitment of individuals. It is no surprise that system development is the least raised as this type of support involves developing organizations that provide the other three types of support.

Science identity was also used as an interpretive lens, examining how competence, performance and recognition in science networks (Carlone & Johnson, 2007) mattered for interpreting how students negotiated networks, and use of available resources through institutional agents. Common themes that emerged are presented below by science field. The physical science participants will be presented first, organized by institutional supports identified as key, followed by how they negotiated their networks to maximize benefits from these networks. An analysis of life science majors will be similarly presented and then a synthesis of findings will follow.

***Physical science students.***

The following section outlines the identified institutional supports and perceptions of climate and science identify that influenced the negotiation of networks by physical science students, providing findings for both parts of the research question three. Raina, Catalina, and Corey are the physical science majors. Each has a unique way in which they positioned themselves in their networks to affirm or counter the science identity they perceived of the field they were in (Stets & Burke, 2000). This also involved a negotiation of detrimental impacts that affected their competence, diminished their connections of performance of science, or failed to recognize them (Carlone & Johnson, 2007). Tensions between supportive and detrimental networks, and networks within science were indicative of these two ways in which they negotiated their science identity.

While physical science students identified direct supports as important and drew on family, peers and staff for these resources, this was tied to their views of science as individualistic and competitive. Their use of institutional supports revealed that they needed respite from this environment and sought counterspaces or a place for coping. The sources of institutional supports were also negotiated in ways that maximized their benefit and minimized negative impacts.

Additionally, seeking of counterspaces or institutional supports was negotiation based on their science identity and perception of climate. How they interpreted the 'chilly' climate, neutrality as inherent to the field, or based on ideologies that they should counter, depended on how they viewed their own science identity relation to the climate. If this climate and experiences affirmed their views of science and/or affirmed their identity, they viewed this climate as part of being in science. If the climate contradicted their views, this pushed them to leave, or seek places to perform science in ways that better aligned with their conceptions of identity (Stets & Burke, 2000). This influenced what they viewed as necessary to persist, and so either identified aspects that aligned with this view, such as being motivated or interested, or performing well, or countered this view as a problem and alienating.

*Institutional supports to persist in physical sciences*

Corey, Catalina, and Raina primarily accessed direct supports, from a mix of family, peers and advisors. As was the case overall, these three participants primarily raised direct supports to persist, eight times as often as raising integrative supports and nine times as often as system linkage/network development, and rarely system development, if at all. The institutional supports most commonly raised as key to persistence were financial support, advice, and academic support, all types of direct supports. Integrative supports were notable as all three raised a noticeable lack of integrative support in their transfer, as all of these students were transfer students. These will be discussed, below, as well as the source of this institutional supports, followed by a brief summary.

Financial support was key to all of these participants. Corey, a 4th year earth and environmental science major, had transferred from an institution that had provided him with a generous scholarship, and needed to make up for this funding by working as a work-study, student employee.

> [other university] got me because of money…when I started college at [other university], the band director gave me a job, and gave me a really big scholarship at the time…[now I work to] …at least pay for my day-to-day activities, whether—[so] even with my parents' support, with my tuition, I am not needing more money just to get through the week… (Corey, EES, 4th).

Raina, a third-year chemistry major, acknowledged the immense support that she received from family, both in housing and financial support as she did not work and lived with other family while at UNIV, since her parents lived more than a 30-minute drive away. Catalina, a third-year chemistry major, required the largest amount of financial support as she was an undocumented student and so had little access to financial aid, and she was a mother of a child under the age of 2 at the time of the interview. Corey and Catalina both also indicated that cost was a very important reasons to attend UNIV, while Raina indicated staying close to home as the only important reason she chose to come to UNIV, while she raised.

Most often, financial support came through family, providing direct access to funds, or direct supports that provided participants with less of a need to spend money. For example, Catalina indicated how her childcare was received from her parents and grandparents, for no cost, but that did not come with academic support:

> …now that I have a baby, they definitely help with like taking care of her, not charging me to take care of her, or like being flexible with that, so that's a big help. And I mean my dad is trying to help me financially too, so they don't necessarily help me in an academic setting, they definitely- I definitely feel supported by them. (Catalina, Chem, 3rd).

Raina too, drew on extended family for financial support, as she was living with her grandmother closer to UNIV, as her home was far away in a suburb. Her grandmother allowed her a place close to campus to live and avoid paying housing costs on campus or depending on public transportation, while her parents worked diligently to pay for her expenses, even though they qualified for free and reduced lunch in high school.

While Corey also receive similar housing and financial support as Raina and Catalina, he also received access to employment on-campus through direct and system linkage/network development support. One of the first employment opportunities he had was as an eco-educator that he applied for because of the advice and guidance of a graduate research assistant that worked with the program. Another work-study opportunity he received was as a music department events coordinator. This job replaces a staff job with approximately four student workers, and he was the first hired through his connections within the department, given his financial need, even though he was not a music major, or even minoring in music:

> The music dept rents out its facilities and before, they had a staff member that worked on that, but now she is not in that position, and they said, 'ok we're going to give it to one of

> our work-study students,' because they have like four of them now, 'just to give them just for some extra money.' It's not a lot, but it's worth coming in… (Corey, EES, 4th)

Commonly, students also noted advice as a key form of direct support. This mean accessing advice from peers, or in the case of Raina, family or formal support structures. Corey suggested he rarely sought academic support, but sought advice on coordinating class scheduling, and requirements, a particularly need as he noted his small department since course offerings were not as consistent offered as in larger departments. This meant seeking the advice of older students and which classes were worth taken, and which could be taken the same semester:

> our department is so small that the guidance you can get from other upper classmen or your professors… all the negative things I've had were just from this one individual [advisor], and it's a shame that our only option…if I've been struggling to figure out classes, I've not gone to him… It's not like I think he's bad at his job, or biased in this, that or the other, I just don't think he's the greatest at the job that he has to do. (Corey, EES, 4th).

The small size of his department meant he could also reach out directly to his professors for future course offerings as well, often bypassing the need for an academic advisor. This small size of the department creates a less competitive environment that fostered this type of cooperation and easy access to advice when needed, countering negative views for a 'chilly' climate.

While these connections could provide integrative support into higher education spaces, they could not guide her into science spaces in the same way. Catalina similarly experienced this support from a teaching assistant in her Latino and Latin American studies, and she credited the institutional supports from these professors as the reasons for persisting although she was being pulled to study Latinx studies but had yet not changed majors. For Catalina, she needed advice on how to plan courses, as she sought to take as many courses she could a semester to save on costs. Catalina also identified struggled with aligning her desires for applying science with what she was experiencing in her classes and sought advice for managing this tension.

Lastly, all three sought academic supports in some way and found them key to persistence. Catalina rarely talked about academic pressures, and talked amore about the social pressures she felt, lack of time, financing school, being a mom, trying to be involved, having to work, but still did mention the key role of teaching assistants (TAs) as providing academic supports for students, and for her specifically. Somewhat paradoxically, she found herself also pulled to Latino and Latin America studies as a field of study because of her interactions and academic support from her TA. Corey, while initially stating he rarely needed help and was a loner and enjoyed also spoke of the ability to receive direct supports, tutoring, from his professors, and they had the capacity to do so. This type of relationship with his professors also mirrored the cooperative atmosphere of the department, where TAs also took some classes with undergraduate students. This reinforced the relationship in class, and generally provided for more dense networks and provided ease of access for the advice he sought. Raina, sought academic support from formal support structure. This was tutoring by TAs in a dedicated tutoring center. Raina sought in math from a TA, and was left seeking alternatives, and turned to her twin sister instead, that reinforced her connection with her sister, but also meant she was hesitant to seek help from this structure again. She was not alone in this assessment.

These three students could have sought these supports from multiple individuals, with more or less flexibility based on the support. While financial supports are limited, especially for Catalina as she does not have access to government financial aid, advice and academic support are available from multiple sources. The following section highlights some of these instances as examples of how students were negotiating their institutional supports.

*Negotiating networks.*

Corey, Catalina and Raina negotiated their networks to leverage resources for their persistence, to reduce detrimental impacts on persistence, and to align with their conceptions of science identity. These will be explored in this section. Students negotiated networks by seeking and assessing resources from multiple sources, particularly if they were not satisfied with the result. Related, students sought to minimize negative impacts from their networks, particularly on their science identity, but this was a difficult process when these negative impacts came from sources of resources. This was most prominently felt from family, as their financial supports specifically were key to their persistence. This process though was influenced but what they conceived of as appropriate performance of science, or competence. Students worked negotiated their networks in ways to affirm their science identity or chosen path to practice science.

Corey, Catalina and Raina sought resources from multiple spaces, often because of pressures to leave science. Corey, wanting to continue his studies in earth and environmental science graduate school, sought to affirm his science and downplayed the negative climate he was experiencing. While Corey never explicitly stated their existed a competitive and 'chilly' environment within his department, he frequently implied that it was an unwelcoming environment. Corey explicitly sought refuge in the music department, noting that this space had "a sense of community" and was more "welcoming," and the location for his close friends, even though it does not align with his ultimate goals:

> …for how I look at the world, being in science, being in earth science, is the way to get closer to my goals and my world view. I'll always have the music community because of all my friends there… some of my best friends are music majors, it's, the music dept, is welcoming, so it's nice that I found a community. (Corey, EES, $4^{th}$)

He additionally negotiated institutional support within the earth and environmental science department. While hesitant to criticize the only formal advisor in the department, "he's not a bad guy…,' he would not see this advisor, after hearing negative experiences form his peers. Instead he noted the size of the department allowing him to seek alternatives: "our dept is so small that the guidance you can get from other upper classmen or your professors, is more valuable than the general advising is…" With his goal of entering graduate school in earth and environmental sciences, he sought to affirm the positive aspects of the department. Still, even in seeking academic supports like tutoring from professors, he also highlighted how he was unsure about the significance and ability to access other resources from professors, as captured in hearing a peer discuss the multiple institutional supports she was receiving compared to the ones he received. This was a bit surprising to him as he also had extensive time doing research with a professor, and another sponsored a science club for which he was vice president.

> I think I have some decent relationships, but I don't think I've made enough impression on any professor, that they are like 'wow I really want to help you, invest in you.' My coworker, she has this professor that said to her, 'I like what you are doing, you're going to go to grad school in north Texas' or wherever it was, 'we're going to get you in there,' and I was like 'wow, that's awesome that they want to help you get somewhere and do something. I don't have that.' (Corey, EES, $4^{th}$)

This perceived alienation was also reflected when he took a class with the professor that sponsored a science club for which he was vice-president. Corey expressed that his relationships with professors were overall positive, but a bit "weird," attributing this to part of the alienation that is normal when studying science, because of intimidation due to expertise.

> [an example of the] weird relationships I have, we were introducing ourselves for this one class, and this professor, is actually the sponsor for the club that I'm vice president for, so I know her, and we've worked together often enough, and she would ask people questions as people are introducing themselves, and she gets to me, ask me the basic questions, and then she kind of keeps moving on, and I'm like, 'What? Ok. Cool." (Corey, EES, $4^{th}$)

Even in the case of peers, and family, two areas that Corey generally saw as providing the institutional supports he needed to persist, Corey still negotiated these relationships, spending most of his time in the music department, and conscious of how he may be interpreted in the same way, referencing the ivory tower of academic as connected to scientists:

> …I always felt disconnected to my family. I think I'm a little snotty about how smart I think I am, but I always try not to be I think to be good at a science… the sheer amount of things that you have to know is vast. And I think that even knowing that someone has a bachelor's degree in some science, you're like 'wow, they know a lot of things together.' And I think that can be intimidating, that [someone who] is younger and doesn't know that, or who is less educated in my family, and feels like I'm being snobby about something. It's like 'no, this is just all the information I have to know to understand these things.' And I think there's some kind of ivory tower scientists are held in, that keeps people from asking too much, for fear of being looked down upon… my hope is that even though they might not talk to me…they see our family can do it… (Corey, EES, 4th)

With peers, this related to his perception of racial climate as a bi-racial Puerto Rican/Portuguese student. Having family that is both White and Black, and 'passing' for White, he emphasized a dual consciousness of understanding White privilege and of understanding racism in the US, giving him both a perspective and access to networks because of how he is perceived:

> I think I get caught in the middle of [UNIV]…I don't look Latino by any definition, when I tell people that I am, they're like 'well are you Cuban or are you Spanish?' And like, 'no, no, but thank you for at least accepting that it's true.'…[at UNIV], where you have a lot of Latinos that look Latino, and I assume that a lot of people don't think I fit into that community because I don't look like it… (Corey, EES, 4th)

In conversations with classmates, he too is racialized as being unable to understand this experience, alienating him from peers on campus, and necessitating a counterspace in the music department, in that "welcoming" environment. While his family also serves as a counterspace, as he notes family gatherings are a place to express his Puerto-Rican culture, it is limited in scope and does not include his performance of his science identity, because as he noted earlier, he could be perceived as snobby:

> …half my heritage is Puerto Rican, and I identify very strongly with that, and everything else is very minor, but I still identify with it, but culturally I'm very, very, stereotypical in how proud I am of my Puerto Rican heritage…I learned Spanish, in classes, because my

> mother doesn't speak Spanish, but my father's second language was English, so I'm almost bilingual? I have a working understanding of it, enough to communicate with a lot of my family, and um we also go to [Kaiser-pseudenym] park every summer, we visit our family members, we have flags everywhere in our household and on random objects, we listen to old Spanish music, we eat traditional foods often enough… (Corey, EES, 4th)

Similarly, Catalina sought supports from others, but purposefully narrowed who she accessed institutional supports from to avoid similar negative interactions. Catalina worked as a community organizer for an environmental justice organization and she sought a chemistry degree to speak more authoritatively about the negative impacts of environmental contamination on her community. A recent transfer student and seeking to minimize her time in school because of the financial burden, she drew on her network of professors she had previously known. Through them she was able to secure employment on campus.

> [teacher 1] helped me make connections… with professors…[who] recruited me, like knowing [Ed Professor 1], knowing [Ed Professor 2], because of the connections I made as a high schooler, I became a lot more interested in coming to [UNIV]. And because of one of those connections with [Ed Professor 3], I was able to get a research opportunity because of a professor she knew, the engineering research pilot that we are doing, is directly because [Ed Professor 3] had introduced me to [Engineering Professor] and so if it weren't for knowing [Ed Professor 3], I probably, I would not have been able to get in touch with the employment opportunity I have now. (Catalina, Chem., 3rd)

While these connections provided access to direct and system linkage/network development supports, sometimes direct supports of advice did not. She was given the advice to seek support from a Latinx support program for help on scheduling classes, as this program was specifically created to support Latinx students transitions and persistence at UNIV. Yet, Catalina's experience with advising was interpreted by her as disrespectful to her undocumented immigrant identity, being told to give up her job and do school full-time, an impossibility for her. She described this as also part of assumptions and blindspots among UNIV staff:

> I have spoken to an advisor from there [Latinx support program]… even within programs like you can feel a little excluded…I've had a few interactions with folks there that it seems like it's still- I just get that weird feeling that because of my [undocumented]

> status, or because of the many, many obstacles I have to take into account when picking classes, or in getting through school now with my own family, I still feel like there is still that, I'm better than you feeling?…I think that as an undergrad, they assume that [students are] on campus, they're dorming here, that they're full-time students, or they don't have to go to work or anything like that, because they are undergrads, um, and that's pretty disrespectful to a lot of it's just being a little more open minded to the issues that some- a lot of students face, and being a little more respectful about that… (Catalina, Chem, 3rd).

This experience not only made her hesitant to explain why she needed to continue working to this advisor, she also refused to seek other institutional supports from this program again. Instead, she felt alienated from this Latinx space. She similarly felt alienated in her classes.

Catalina's experiences in her science classes, at home, and in her community, pushed her to leave science because of how her science identity misaligned with the perception that others had of scientists. In classes, she viewed other Latinx students' goals of succeeding in medicine, or pharmacy as part of social mobility and leaving the communities in which they were raised, a goal antithetical to the social chance she sought to do with her performance of science.

> …everyone in there is like pre-med, it's like, you feel that disconnect right away, um, there are a lot of students of color in the classes, but they are all premed… those first semesters of chemistry that I took… I felt still really passionate about [studying chemistry], and I think part of that reason was because I had worked with that professor before, during high school [as part of community activism and extracurricular HS science project]…that kept me interested, he like, he during class he would talk about social justice as well, and like using chemistry for social justice, whereas, I'm noticing more here, it's more premed, pharmaceutical, you know, geared for them, instead of geared for a social, social justice kind of way. (Catalina, Chem, 3rd)

Similarly, with her family, her father insisted she persist in a chemistry degree, for the financial benefit a chemist job would provide her. This again misaligned with what she sought from studying science and highlighted her misalignment between how she sought to be perceived, and how others were perceiving her. This was captured in an emphasized interaction with community members, as she worked to organize around the environmental issue is her and their community:

> …like señoras*[ladies, or plural ma'am] or señores*[plural of sir, or gentlemen] ask me, 'que estas estudiando,' what are you studying, and well I tell them 'quimica [chemistry],' like, like, right away I get this reaction 'ugh.' It's like, it sucks getting that reaction from them because I felt like it- they think highly of me, I just feel like they don't see me at the same level… I just feel like they see me like, way up here, when it's not like I'm studying chemistry to be better than anyone else… I'm not doing it for a fancy paying job, I'm not doing it for anything that traditionally you would think of as a scientist, right, and that's hard, it's so hard… I don't … if it's that, that thing, where she thinks, she thinks that she's better than us, so she's going into science and not for the community, you know what I mean (Catalina, Physical, 3rd) **lit.-in this context she is referring to older, respected people in her community*

These perceptions of what science represented to others was antithetical to what she wanted for her own science identity, one that would be in service to community, seen when she demarcated her research employment as an organizing opportunity rather than a science opportunity. This was also captured in how she interpreted her professors framing a social issue. As this professor seeks to real-world applications of the content, Catalina still sees this as misaligning with the performance of science she seeks:

> my professor in my organic chemistry would start off with a molecule of the day [and] there are a few times where he would give examples of how you can use it ... and how a lot people couldn't afford it, but he didn't really go into detail of, well, why can't they afford it, what people can afford it, what can students do if they are going into pharmacy, or if they are going into being a doctor, what can they do to, break some of those barriers …it was more like, oh yeah, this is a drug, it's expensive, people can't afford it…whatever, and that's it. they didn't really go into solutions for students to really think about… if they are not being exposed to it by their professors, then they-they might think that it doesn't apply to them, or they shouldn't care about it… (Catalina, Chem, 3rd)

By the time of this interview, Catalina had all but decided to leave chemistry as a major, finding it conflict with the performance she desired. Only her desire to enact social change, and the potential of science in helping her do so as a community organizer in an environmental justice organization, that has kept her from changing majors sooner.

> I was prepared, for the exclusive feeling in the science classroom, as a college student, but I didn't expect it to be as bad as I am experiencing it if that makes sense... I think this is where my job comes in too, as a community organizer, and specifically working in and environmental justice community organization, it kind of forces me to make those

> connections… but like if- I'm pretty sure that if I wasn't working there…I probably would be debating changing my major a lot sooner than a lot later in. (Catalina, Chem., 3rd).

Catalina also referenced herself being pulled to Latinx studies because of her connection and expertise in the material, in addition to the close connections that she lacks with professors and TA's in her science classes, where her identity is affirmed. This explicitly captures her alienation from science and a more welcoming and affirming space in Latinx studies:

> …there's that disconnect that 'well you learned this in class, so here's the quiz.' So yeah, it's not- in science classrooms, I don't feel very welcome. With my Latino studies class… me and my TA are like- we're close, because when she starts talking about the history of a country I know already, that's so messed up because of this, and this, this, or she asks about does anybody know this dictator, she doesn't call on me, because she knows I already know what I know… (Catalina, Chem, 3rd)

Raina, seeking to become a forensic pathologist, also sought multiple places of support. She depended heavily on her twin sister emphasizing that she had been her classmate for her entire schooling. While seeking tutoring help from TA's, Raina emphasized that this was a rarity, and that with her sister, she had no need for peers or academic help, since her sister would provide these supports. Raina also relied heavily on family like her grandmother for housing, that was significantly closer to UNIV than her parents' house. Still, Raina had to negotiate these supports with other members of her family that she called 'old school' that would question why she was going to UNIV, pushing her to work and not be educated because she was a woman. Raina credited her parents, particularly her mother as fiercely opposing this message, with Raina imagining "of course they wouldn't say that, because my mom would kill them, wring their throats, because that's how my mom is…"

Similarly, Catalina, who credited free day care from her mom and grandma as helping her to persist, also felt a pull to leave a school with this support:

> I was ready to pick up my baby, and she [Grandma] was like 'mija[daughter]*, you need to go home and relax.' And I'm like, 'why?' and she was like, 'vas ir a trabajar? [Are you going to work?]'… 'yeah, I got to go to work right now.' 'No you need to relax, recien casada [(you are) recently married]…' I don't know if she is implying that just because of that I'm not supposed to do anything anymore, that he is supposed to take care of me, because that is- that's how she was… that's not the best thing to say to someone who is trying to get her own life, get ahead… it rubbed me off the wrong way. Obviously I didn't say anything, because she's my grandma, but I did talk to my mom about it, like she told me the same thing, that my grandma, was like a housewife, and taking care of the babies, the husband brought home the money and that's it, Just thinking about… how many moms say that to their daughters. (Catalina, Chem, 3rd)
> **lit. but shortened version for mi hija [my daughter]. Sometimes used to refer to an endeared younger person, often but not exclusively, among family.*

Additionally, having received undesirable academic supports from tutoring, Raina still emphasized that institutional agents had a responsibility to provide these supports if needed. Still she was strategically seeking to access supports should the need arise. Seeking to reinforce her identity as a science student because of her competence, she emphasized that only the best students study science. Receiving academic supports, such as the accommodations she was afforded because of being deaf would not let her to "do it on [her] own:"

> [the DRC] offered a lot of support for that [her disability], but, I haven't really needed help. I especially don't like asking for help, because I like the challenge, I want to win, because I am better because I tried harder. I don't just want to fall back on like for example, someone write up my notes for me…(Raina, Chem, 3rd)

Yet, Raina also noted that should she struggle academically, she would access these resources. Raina struggled with what seeking supports meant for her identity, and it did not align with what she conceived as her identity to be, competitive and the best.

Raina's struggle was that accessing supports represented poorly on her competence, and recognition of doing science. She expressed that if she were to receive academic support, "[i]n order to stay competitive with all the other people that want to go to med[ical] school especially. Because there, I'm told it's way harder, and teachers won't probably be as supportive, so I want to learn how to be on my own." She reinforced this ideology of competitiveness as normal and beneficial in science, and reason to not access institutional supports, even though she has access to supports for her dis/ability. While she was a high achieving student, this framing of access to supports as counter to what a science student is, identifies a barrier to accessing supports.

Raina additionally emphasized that she did not seek to make friendships at the time because of the lack of a need to do so, initially in her 2-yr college environment because of the lack of utility from them: "because everyone goes their separate ways, there really is no point in investing in a friendship, especially since mostly I wasn't that interested in making friends" and instead saw them as competition. She also emphasized that she only provided academic supports to others as a requirement for scholarships. Raina so strongly sought to affirm her science identity, that when she found a forensic science program at another university, she sought to transfer and was already set to transfer and change majors at the end of the semester when this interview took place. She argues that this would reinforce her vocational trajectory and align more with what she sought out of their study of science, although this meant no longer being a classmate of her sister, who was continuing at UNIV. Raina also emphasized that she would have continued in chemistry had she not found this program, and that it was reason enough to leave, emphasizing her desire to align with a science identity that she sought to affirm.

Corey, Catalina, and Raina all navigating their networks in ways to attain the institutional supports they identify as necessary to persistence, while also working to minimize detrimental impacts of interactions with family, peers, or UNIV staff. Concerning is the choice to not access institutional supports when present, most prominently from Raina, with Catalina, Corey, and Raina actively choosing to alienate themselves because of negative interactions with peers, family or staff. Still, Corey and Raina interpreted the alienations and 'chilly' environmental as an aspect of being a scientist, and they sought some form of space to belong, the music department for Corey, and her family for Raina. Catalina on the other hand, found multiple networks, from which her identity was challenged, and more so the science identity she wished to realize. This left her in a place where she felt pulled into another major and was planning to leave chemistry major with a chemistry minor instead.

***Life science students.***

The following section outline the institutional supports that life science student identified as key to persist. These supports were overwhelmingly guidance to reach their vocational goals. This is followed by an examination of how these students negotiated their networks in ways that helped them maximize the benefits of these resources and connections and affirm their science identity, even though it differed than what they saw amongst their classmates.

Similar to physical science majors, life science majors sought multiple sources to access similar resources, but while physical science majors were primarily seeking alternatives to institutional supports that were seen as inadequate, only Angelica shared this sentiment. Eduardo and Maria connected with institutional agents, individuals within institutions of society that can transfer key resources to counter social stratification, and Eduardo sought to follow dutifully the advice and guidance of one institutional agent specifically. Maria on the other hand took a more cosmopolitan approach, seeking alternatives sources of advice, in order to have as many sources of institutional supports as possible. Similar to physical science majors, the life science majors all viewed science classes as competitive, but they also challenged whether it needed to be this way, particularly Angelica and Maria.

Just as physical science majors negotiated their networks along dimensions of their science identity, life science majors also did. Unlike physical science majors, Maria and

Angelica saw the competitive environments as artificially created, part of the culture, and related to accessing academic supports:

> it's like they get that competitive ideal bred into them that you need to be better, that you need to do your best, better than before, and you think by stooping down, it's not stooping down, but that you think that you are under the impression that you by asking for help, by seeking advoca-by seeking services, by seeking tutoring, that you failed (Maria, Bio, 4th)

A student with limited vision, Maria additionally tied this to accessing of services as also viewed as stooping down, but also explicitly likened it to seeking tutoring in general. She additionally noted that she suffered through most of a semester of a math course and performing horribly, as she refused to use her services, which included assistive technology in the classroom.

Eduardo on the other hand, saw this competitive environment as a consequence of size, not a 'chilly' climate, downplaying the competitiveness and hostility in science networks. Still, he like Maria, struggled within this tension of accessing academic support, from tutors or professors even when readily available:

> … transferring from a community college to a four-year university, and it is more tough and there is more people competing, so you could have competition…physics, organic chemistry- certain science classes. Um, and I didn't go too much with them [tutoring], which obviously, I should have, but at the same time- first I felt like I had a handle on it, but obviously I didn't so, now I have to withdraw before I got the bad grade. As for office hours, and TAs and all that, I don't usually go to that too much, and I know I have that resource, but it's just something that I don't do. (Eduardo, Bio, 4th)

Still, the way they positioned themselves influenced how they interpreted this competitive environment. Maria, and Angelica both saw this as a result of the field having students vying for limited medical school seats, why Eduardo framed it as part of his agency, as something that "he just [doesn't] do."

Angelica additionally noted that this creates a negative environment where cheating networks are established and rampant, turning what should be a cooperative environment into a hostile one, and also places her in a position of competing with students that have unfair advantages, but also who she must work collaboratively with on classwork.

> sometimes you get those people that will cheat, and they are your lab partner, and you're stuck with a cheater as a lab partner, and you don't want them to cheat, but you also don't want to tell on them because they're your partner, and you don't know if you're going to get in trouble too, so you just say 'no, let's do something different,' but it's- I can't, I always get those kind of people and I don't know what to do in those situations. If I should say 'hey, they're cheating, they're copying someone else's work and they're still getting an A in the class, and you haven't even noticed, that they took that lab from somebody else in a previous year.' It happens so many times, in this school sometimes, and it's crazy because we do [plagiarism check using software], so I don't know if they don't really check that or not, because they're just taking other people's lab reports, from other years, how do they get away with that? (Angelica, Bio, $4^{th}$).

Unlike physical science students, life science students persisted even when they felt their identity did not align with the image they perceived of science performance in their classes, as in the case of Maria. Maria briefly questioned switching majors because of the climate of 'getting through,' classes exhibited by others, not because of competition. Angelica did not find herself aligning with what she perceived as a hostile and competitive environment, from both peers and staff, but never questioned persisting.

Eduardo, who viewed himself as not entirely aligned with a science identity at all, saw medicine as a "means to an end," with the end being spreading his religion. Finally, unlike physical science majors, life science majors did not feel as much of a need to cope from a 'chilly' or competitive environment. Rather than seeking counterspaces, Maria instead sought to affirm her ethnic identity, because of the dearth of visible Latinx presence in her science classes. Eduardo, not expressing feeling a negative climate, had a supportive environment, referring to his church network as his family, but sought to provide social capital rather than draw social capital from this space, as a lay minister. Angelica, the one life major that did express hostility from being a science major, and did so along multiple sources, did not seek nor access counterspaces, and instead withdrew from family and peer networks on campus. Yet, she still persisted and was expecting to graduate in the semester she was interviewed.

*Institutional supports to persist in life science majors.*

Life science majors accessed direct supports, and integrative supports, involving guidance on how to navigate their particular goals, as well as how to integrate into science spaces. For Maria, this was mix of integrative support from her parents, who coached her on how to network, and act, and perform within science spaces. This also meant seeking advice and guidance given her particular path from biological sciences into chemistry education. Similarly, Eduardo, guidance from the community college setting to UNIV, and into the culture of UNIV was vital, particularly as it related to entering medical school. For Angelica, this meant finding advice to meeting her goals of entering medical school, given relatively low academic performance comparable to her peers.

Maria, the only interview participant with scientist family members had parents that both had baccalaureate degrees in computer science, a rarity even among the entire UNIV sample. This connection afforded her networking strategies, or even advice on proper norms of events.

> My mom, a little, she was like, always pushing me, go find the Latinos. I was like 'ok mom.' Because when she was in college, her thing was her friend started the first Latino organization [at her school] so she always has these memories, 'oh we used to do these balloons, we used to have these boat bashes,' she did it more for the social aspect, but now she recognizes like there is a professional benefit to it too, like in the beginning it was a lot of me being, 'oh my god mom, how do I dress for this event, how do I go about talking to someone,' and she was like, 'well , this is what you say, and this is what I would say in this situation,' and I would be like 'ok.' But as things shifted, I looked again to older peers, who kind of been there, done that, and I was like, 'hey, I know you worked with this person, what did you say, how did you get in good.' But I had to meet those people before, but now that I have that network, I know I can turn to for different scenarios. (Maria, Bio, 4th)

This afforded her advantages over other students, and yet she sought a broader network under the advice of her mother, particularly in connecting with other Latinx students. This more cosmopolitan network helped her integrate into a cultural center for Latinx students on campus. Her integration there also provided knowledge on social movements that would eventually guide her vocational aspirations to be a teacher.

Additionally, Maria identified guidance and advice as key to persistence in guiding her to meet her vocational aspirations. As she had a recent surgery, she worried about how this may affect her academic status and sought advice from an honors college advisor. Maria received advice on how to navigate taking time off if necessary, and planning for coursework the following semester.

> …I had a surgery on my spine, yeah, I'm ok now, obviously, so it wasn't an emergency, it was elective, so, but she [honors advisor] was like someone who I could talk to about it…It's not something I talked to my parents [about], because, as worried as I was, I knew they were like, 60 million more times worried, and I didn't want to add to it… (Maria, Bio, 4th).

As mentioned, Maria contended with her parents' advice and guidance, with their desire that she study another subject. This is one reason that Maria sought older peers rather than parents for advice on classes they had literally "been there, done that" and in her particular context, rather receiving more general advice from her parents. Additionally, while her parents' advice is seen as good advice by Maria, it is always coupled with the push out of science:

Eduardo identified direct supports, and system linkage /networking supports as key to persistence. Being a transfer student that had taken some time off, Eduardo was concerned about guidance to entering medical school. He found a counselor at the same Latinx academic program that Maria and Catalina used, that was willing to help him in his transition from community college to UNIV. He identified connecting with her, and the resources she guided him to, such as academic support, advice on courses to take and clubs to join, bridging connections to research opportunities, and even added a psychology major in order to be prepared for new section to the Medical College Admission Test. While these supports were key, just as important was that Eduardo could simply access one person for the supports that he needed, as this provided an efficient way to get to medical school. In reference to an undergraduate research program that focused on medical research addressing medical inequalities, a program Rachel had connected him, with, and that helped him reach his end. To him it was: "…just a program that I heard about through [Rachel], which 'that's going to help me? Ok let's do it.' " To Eduardo, the advice and guidance as direct support was more important than enacting connections to his own agency through the practice of science, highlighting the importance of non-science institutional agents to support him through a science program.

Expressing little connection to the field or medicine asides from a "means to an end," this advisor was identified as key to his transition from community college and persistence. Eduardo additionally credited his church with providing him with both a space to belong, but also reduced-price housing given his work for the church, and their desire to see him succeed.

Unlike Maria and Eduardo, Angelica encountered hostility and struggled to find a place to belong. Similar to Eduardo, Angelica found an advisor she saw as key to guiding her to her vocational goals of becoming a physician, given her relatively low GPA of 2.9 (z-score= -1.049). Angelica identified Laura (pseudonym), a pre-health advisor, as outlining a path to medical school given her situation, and this affirmation of her science path and identity drove Angelica to persist. While compelled to reach out to other advisors, her major advisor, and her liberal arts and sciences college advisor, Laura provided her with the affirmation to resist hostility, from peers, staff and family. Still, family provided for her, and like Catalina and Raina, she had an ambivalent relationship with them.

Like the physical science majors, while the institutional supports were relatively simple, accounting for advice, guidance, and direct supports like financing and housing, whom these institutional supports were accessed from were negotiated in networks to minimize detrimental effects. The following section outlines how life science majors negotiated institutional supports to persist, primarily through their science identity

*Negotiating networks*

Unlike physical science majors, life science majors sought to minimize their science identity when compared to that of others in their classes. Eduardo refused to identify as wanting to be a scientist, and Maria viewed pre-medical students as dissimilar to what she viewed as her science identity, even though the majority of students were pre-medial majors. Angelica withdrew from peer networks and saw her identity as an alternative, but valid identity, but needing to be justified. Accessing institutional supports to persist was guided by these identities, resulting in particular decisions to access institutional supports.

Eduardo seeking to not align with a science identity was explicit. Like Raina, Eduardo limited his involvement with peers, family and staff, save in accessing institutional supports. Eduardo also made it clear that Rachel, a counselor and program developer for a Latinx medical scholars' program (pseudonym), was exclusively who he sought guidance from for his academic program. Should the need for academic support arise, he would use a Latinx academic program for supports, after having had a negative experience seeking academic support from a formal tutoring center within a STEM center.

> For some reason, the tutor didn't show up on time for one, which I was like, 'ok you are a tutor you are getting paid for it.' The other thing was that the guy at the reception area, he

> was like 'oh, go he'll be here, and when he comes, I'll call you.' He made it seem like he was going to call me, but he didn't, so I was just waiting around, 'like alright, I'm just wasting my time here, I'll just go study by myself.' (Eduardo, Bio, 4th)

Like Raina, Eduardo also noted that negative experiences caused him to not return to a formal tutoring center. Where Raina chose to seek alternatives, Eduardo returned to Rachel to seek academic support and was directed to tutoring services within a Latinx academic program, the same that Catalina and Maria had accessed.

Instead of his science identity, Eduardo emphasized the importance of his religious identity to his persistence, calling his church community his church family. His church not only provided him with direct supports for housing, it also provided guidance in applying and entering a 2-yr community college. Eduardo expressed that it was his church family as opposed to his family that he included into his decision to go back to school. Here he emphasized the centrality of his church networks, as a pseudo-family network, given that he was estranged from his family until a few years before this interview.

> I didn't really include [family] in me going back to school. I actually included my close friends from church more than them. And that was more me not wanting to share much…. The church has a big role in the decisions I have made initially, then my family kind of helped out… (Eduardo, Bio, 4th)

Eduardo still drew on his family for institutional supports recently. Expressing that he only reached out to his family after having entered and done well academically in his 2-yr program, and even though they now support him, he still sees his church family as primary:

> I have that network of people that are encouraging, and initially it was the church people, and eventually it was my family as well, not because they didn't know, er, not because they didn't want to for me, but because they didn't know… they don't fully understand it… or me it wasn't the school, it wasn't my family, it was my other family, my Christian family, that was key…. (Eduardo, Bio, 4th)

Still, now he drew on family for financial support that allowed him a reduction in work hours. As he desired with medicine, Eduardo had viewed evangelizing as an approach to create or reinforce networks of support, similar to his own experience. Having already drawn on his brother for housing previously, he worked to develop a closer relationship with his brother by attending church together, drawing him to church by his evangelizing. He emphasized that the change in demeanor and responsibility, from a 'D' high school student to an honors college student near graduation, helped promote the benefits of church to his family, and provided a justification for financial support from parents.

Angelica contended with multiple negative experiences from advisors. While she eventually found an advisor that affirmed her path and guided her to a plan that affirmed her goals, this was after this was a rarity, and only occurred as an upperclassman. Her experience with Laura was a stark contrast to her previous experience with multiple advisors, two of which are highlighted here. In one experience, a counselor advised her to switch majors to a similar field because of her low GPA, such as nursing.

> I went to meet with [Laura] because I had just came from bad bio advisor meeting, and he was telling me, 'don't be- you can't do medical, you should just be a bio advisor.' And I just sat there like, 'what, what are you talking about? I just did all this and you're telling me to be a bio advisor? No shame on that, but you just told me that all this hard work I've put into it, [and] don't even try to get into nursing? that it's too late for that too…' (Angelica, Bio, 4th)

While Angelica was upset over receiving guidance away from her goals, in another experience, advisors contradicted each other and may have given her advice that was detrimental to her academic success. Still, Angelica found Laura only because she felt compelled to see multiple advisors. Unlike Maria, she was not in search of multiple perspectives, but like the physical science majors, was seeking alternatives to inadequate institutional supports. It was Laura that helped her make a plan that would eventually guide her to medical school. Aside from incorrect advice, she also felt that other advisors were not concerned and dismissive of her:

> Laura was like ‘don’t worry about it, not a lot of people graduate with a 4.0, and you can do a post-bac[calaureate program], you can go out of the country…’ no one told me that in bio[logical sciences department], or anything else. So she calmed me down… but bio[logical sciences] advisors, they are so scary… I get a little bit of anxiety attack because they- it’s like they go through everything, and you know you haven’t done well, because, I mean, you’ve had bad experiences already, so you tell them ‘oh yeah, I’m going to better myself, ‘and you have to take all these classes, [but] I went to one advisor, and they set up my classes, [then] I go to another bio[logical sciences] advisor, because they don’t give me the same one, and she’s like, ‘I don’t know who did this for you, but it’s really, really, bad, and you should drop a class.’ But I can’t drop a class because I'm on financial aid, and it will mess up my financial aid… (Angelica, Bio, 4th)

Angelica also shared negative peer interactions as the physical science majors did, and like them viewed it as a result of the climate of competitiveness. Angelica struggled with this as she viewed biology as an inherently cooperative science, but in an early class found an opposite message reinforced by faculty:

> I’m like, 'what is this? is this fight club? what’s happening? You are making it seem like such as a competition.' And we should all be working together, we are going to be working in groups. Bio majors, we always work in groups, so I don’t understand why they pit people against each other. I don’t know why? There are enough seats to graduate, it’s not like one has to be better than the other, I don’t get it. I don’t like it. (Angelica, Bio, 4th)

This attitude was one of the reasons that she withdrew from peer networks, on top of the cheating networks that she had to contend with, as she mentioned only one female friend she could depend on. Her bonding with this peer was based in a common negative shared experience with peers.

Angelica’s negative experiences centered around overt discrimination and alienation, as well as contending with networks of academic dishonesty that existed among her peers. Angelica worried that this discrimination she experienced was centered around gender, as an encounter with a Latino male student in her biology class reinforced a sexist view of science, as he told Angelica and a female lab partner that they would do the “bitch work,” a statement that Angelica expressed was not an isolated incident. The response to this incident by her TA was being reassigned to another group with more supportive peers, but Angelica internalized this as a reason to withdraw from peer networks, seeking support only from her female peer that was with her in that group, and continuing to do for multiple years in the programs. Angelica asserted that they both withdrew from peer networks because they had both repeatedly experienced overt discrimination stating that this was not the first time a male student had addressed her disparagingly, nor the first time she experienced being marginalized in class:

> …he spoke Spanish, and [I said] 'I think I saw you in my Spanish class, or in my Latin American studies class,' and 'no I didn't.' It was like 'uhuh, yeah,' and I'm like 'what did I do? Was I mean in that class?' I don't know what I said- I was very confused. So I ended up working with myself for that whole class. (Angelica, Bio, 4th).

Still, other peer interactions noted earlier reinforced this withdrawal. Angelica felt unsure about how to proceed interacting with peers that offered her old labs and quizzes that instructors would reuse. While she refused to take these, this left her in an awkward situation where her lack of doing so placed her in a marginalized place among her peers, but also at a disadvantage academically to those that were engaging in these practices.

Angelica similarly had to negotiate family as a place of institutional supports, through direct supports, as well as a place of more subtle hostility. Angelica was thankful for the financial and support and housing that allowed her to study but was more ambivalent about the expectations because of this support. This included caring for her younger brother that she viewed as old enough to care for himself, and the request to care for him as tied to cultural expectations that were inherently contradictory. These 'mixed messages' she received were interpreted as a subtle way of discouraging her while seemingly encouraging her:

> they teach us, 'you can be independent, you can be strong, but at the same time you have to serve your brother, you have to take care of your brother, you have to clean for him,' even though he's 15. It's like 'hold on, you're teaching me two different things, so I don't know what I'm supposed to listen to… you're teaching me that we are equal, but we are not equal…' it was a lot of mixed messages when we were little (Angelica, Bio, 4th)

Additionally, Angelica had social obligations with family. While her mother provided Angelica with transportation to and from campus, this also meant that Angelica would need to plan for unanticipated detours. For example, in one instance as she sought to work on a laboratory report, she was obligated to visit family with her mother, that drew her from her academics, or marginalized her from family, and counter cultural norms.

> we have to support our family, were not the type of culture that we leave our mothers and fathers, and our uncles and grandmas alone, we basically take care of them too. [But] they knew I had a lab report, and I had been doing it since the early morning, [and]… they decided to go to see… like the Spanish awards…'we're going to hang out over there…' it finished at 10 something, and I was still there, doing the assignment, and they're like 'oh you're such a good student…' I don't know why they do this, and I end up having to go, because my mom picks me up from the train, so wherever she goes, I go, so I have to be sure to bring all my stuff with me…[they don't understand] it's not, you spend one hour on school work and that's it, like it's a whole day thing… (Angelica, Bio, $4^{th}$)

This marginalization she attributed to a lack of understanding. While her mother had a 2-yr associates degree, Angelica wondered if her mother truly understood the differing expectations in a 4-yr biological science program. Angelica also wondered if there were more pernicious reasons, expressing a feeling of half-hearted support. Similar to Catalina and Corey, she implied if her family wanted her to succeed, but that a 4-yr degree in science conveyed a status that inherently alienated family.

> they try to be supportive, but at the same time they don't want you, because they still want to be the better one. I don't get it, I don't understand, I just want to be done. 'Just help me be done, you'll benefit from this too, so just help me out here.' I don't think they understand that concept. (Angelica, Life, $4^{th}$)

Maria similarly felt ambivalent about the support received from parents. Having parents with science degrees afforded her with advice and guidance other participants did not have. Yet, she actively chose to find others for advice and guidance. Maria's parents sought to insulate

Maria from the experience they remember having as science majors, and so Maria's mother in particular would encourage her to leave science:

> My mom honestly sometimes, no, not sometimes a lot of times is like 'why, why are you doing something so hard, mamita [little mama]? You should do communications, or like, business…'[be]cause I don't know. She likes the education aspect, she's like yeah, she was totally happy with me doing history [considered as a major], and she's supportive now, but she's like 'oh you should take a communication class,' like, 'keep it easy.' (Maria, Bio, 4th)

Still, Maria's parents were an important source of direct supports, as well as integrative support, but Maria sought to narrow the scope of the support from her parents to socialization, and instead sought advice from older peers and formal advisors around coursework and programs.

Maria suggested two reasons for this bounding of supports. The first reason was that she sought advice from students that actively experienced what she sought, and so her parents having taken courses years ago at a different institution could not provide the same perspective as a peer that recently took a class or participated in an extracurricular program. The second reason was worry of compounding her parents worries, given the worries they already for her, and so Maria aimed to reduce the pressure from her parents to leave science by avoiding the topics altogether.

> I feel like they are so dramatic too, like If I start mentioning a problem, they'll be like, [ugh-grunt] 'you should go see this person, go see that person…' Oh my god. And 'I'm like mom, it's ok, this is normal, everybody has these problems.' And then it's another reason for her to be like see, 'I told you, you shouldn't have done science.' (Maria, Bio, 4th)

Maria was able to reach out to formal counselors, as well as informal advisors that were former professors as she indicated that she cultivated advisors in many spaces. She sought advice from formal counselors in multiple places, for multiple perspectives, where Angelica sought someone that would affirm her desire to persist and enter medical school, rather than encourage her to seek other majors or vocations.

Even though Maria developed a broad network for institutional supports, it took her some time to develop agency to draw on institutional supports. For example, having limited vision afforded her access to accommodations through the dis/ability resources center, Maria explicitly expressed a desire to not access accommodations, because of how it would affect her competence. Yet, her time developing her ethnic identity that she associated with social activism and social change, around issues like the Orlando PULSE shooting as well as activism around ACCESS Bill, a state bill that would provide state financial aid to undocumented students after establishing residency. Maria credited both the activism around the ACCESS bill as well as the development of agency to affirm others through their struggles as providing the impetus for accessing accommodations. She felt compelled to justify their access and did so by advocating that the use of accommodations would assure their continuing availability for others, and that it was "silly" to view not using accommodations as affirming her science competence.

> I was like ok, I guess I'm good, I've been doing good in school, I'm going to college… I'm not going to be that weird kid… needing this weird adaptive technology, like I did good in school, I made it this far… but after a while, it was like, this is nonsense. I know that I need these accommodations, I've had them my whole life…but I was, I was very stubborn and resistant to it at first. But then that idea that was pushed on me, you have to learn to advocate, you have to learn to advocate, and then again… learning that these things, these services that we have, they didn't always have them. People tried really, really hard to get those services, that too kind of shook me, like whoa, if I don't use them, what's going to happen to them? Are they going to go away, are people going to think they are not important…? (Maria, Bio, 4th)

Even though Maria sought accommodations, she also worked independently on assignments. She attributed this to a fundamental difference between students that studied science to learn about it, like her, and those that were only trying to "get through" science to reach medical school.

This provided alienation within classes, since the culture of classes was shifted to achieving high grades and not necessarily understanding the science. This artificially created competitiveness in classes, and she saw little academic benefit to working with peers, instead depending on them for advice and as a place for socializing and coping.

***Synthesis of findings.***

All interview participants expressed common institutional supports for persistence. Financial support was raised as key to support for most participants, as was the desire for advice and guidance that affirmed their vocational pathway, or more broadly, their science identity. All participants were also able to mobilize the resources they needed to persist. Yet students had to purposefully work to negotiate from whom, they accessed supports, and limiting contact or institutional supports in order to minimize detrimental impacts.

Three major findings were noticeable, and these were the: (a) purposeful cultivation of multiple sources of institutional supports, (b) need for affirmation of their science identity, whether through legitimizing the performance or vocational pathways, and (c) purposeful negotiation of networks to access institutional supports while minimizing negative impacts. The only major difference between physical and life science majors was how they interpreted competitiveness and hostility, with physical sciences majors more often referring to competitiveness as part of the culture, while life science majors expressing the artificial creation of competitiveness.

Participants purposefully cultivated multiple sources of institutional supports. The purposes varied though. Some chose to seek multiple sources in evaluating institutional supports as inadequate, primarily the physical science majors. Others, like Maria sought multiple sources for additional perspectives. Participants showed a marked ability to evaluate the effectiveness of institutional supports related to advice and academic supports, save Angelica, who was given incorrect advice on her course scheduling. This suggests that accessing institutional supports is generally not an issue, and that students not accessing formal institutional supports is a conscious choice based on their agency.

Affirmation of their science identity was also important but differed amongst the participants. For some, it was important for the affirmation of their vocational goals, and this guided affirmation reinforced their persistence. Angelica is again the exception, who persisted and was expecting to graduate while only recently receiving consistent encouragement to leave. Key difference in responding to a lack of affirmation are important to note. Catalina, who sought to build on her activist work with expertise from studying chemistry, found it difficult to reconcile her desired performance of science with how others perceived her study of science. Most notably, the alienation that she began to feel from those that she sought to help most, her own community members, suggests the importance of alienation form groups outside the university are as important as experiences within the university in influencing persistence, as she planned to leave her chemistry major. Others, like Raina, and Corey saw the competitive environment as affirming of their competence, with this alienation from groups outside the university as inherent to studying science, since it was to them an elitist endeavor. Yet Raina's affirmation of her vocational goals was enough to change majors, to one that more aligned with her science identity, reinforcing that some movement between majors is for affirmation and not due to negative experiences.  Maria, considering leaving biology for a chemistry major, had a path outlined and affirmed by advisors, that was enough to prevent her leaving, suggesting that clarity around utility of degrees to future occupations could prevent movement between majors. Lastly, Eduardo who shunned a science identity, still had his shunned identity affirmed by guidance to 'get through' the major, suggesting individualized local support matters for affirmation of science identity and subsequently persistence in science majors.

All participants actively negotiated their networks to maximize access to needed supports, while minimizing detrimental impacts. Among family, Catalina, needing childcare to persist, and had to contend with pressures to leave science and school. Maria, Corey, Angelica, and Raina similarly negotiated ambivalent relationships with family, with Corey feeling alienated, and Angelica purposefully withdrawing as much as possible. Raina, through her mother, did not need to contend much with this, as her mother shielded Raina from other family that encouraged her to leave school, but was still a pressure felt. Maria, contended with this by limiting the scope of institutional supports to non-academic support, an option she had, that others did not, as all others had minimal experience with higher education.

Among campus staff, networks were also negotiated among participants. This was most often done to find alternative sources to institutional supports deemed inadequate. All participants expect Maria expressed some sort of search for additional institutional supports for this reason, with inadequate advice or guidance most often expressed. Raina, and Eduardo additionally expressed inadequate academic supports, with Maria implying this was the need for accessing services as well. Angelica, receiving inadequate advising, still felt a need to continue seeking advising as she sought routes to continue her desired path, even if this meant experiencing demoralizing meetings with advisors. Given the importance attributed to advice from Laura by Angelica, and Rachel by Eduardo, this suggests the importance of an advisor that affirms students' paths, but also had a developed relationship. Yet, Angelica only found Laura after becoming an upperclassman, meaning that Angelica navigated many and multiple advisors that did not have an established relationship nor affirmed her path, and she still persisted. The importance of a quality advisor with respect to the needs of the student, whether it be affirmation or direct support as in advice in choosing classes appears dependent on the individual student.

Lastly, among peers, participants overwhelmingly bounded and controlled the nature of their peer interactions, insulating them form detrimental impacts. Corey, Maria, Catalina, and Eduardo had established peer networks explicitly outside of science, in the music department for Corey, an honors program for Maria, her work with a non-profit for Catalina, and the church for Eduardo. Raina, Angelica, and Catalina withdrew from or sought no need to engage with peers extensively, with Raina depending on her twin sister, and Angelica with one peer who shared similar negative experiences. The role of network size does not seem to matter with respect to offering a space for coping in the case of these participants persistence, but instead having the presence of others- even one- to share experiences with as important. Still, with Catalina planning on leaving science, this raises questions to the importance of a support network on campus among peers, as she already had an established network among faculty.

# CHAPTER 5 DISCUSSION AND IMPLICATIONS

This study examined the persistence of students in science fields, due to social capital, as a way to attain more equitable outcomes for URM students in STEM programs as well as to increase the human capital in STEM professions for the continued economic development and technological advancement of the United States. Among URM students, Latinx students are the largest minority population and growing in proportion (Fry & Lopez, 2012). Improving the persistence of Latinx science students is also seen as key for maintaining a pool of STEM human capital (Chapa & De la Rosa, 2006). This chapter will provide a brief overview of the study. Then each research question will be answered individually with major findings discussed in relation to existing literature, and interweaving recommendations for research. A summary of these recommendations for research are presented, followed by recommendations for practitioners is presented after.

## Overview of the study

This study examined the impacts of social capital on persistence along three research questions:

*1: Does social capital predict 1st and 2nd year persistence for first-time physical science, life science, social science, other-STEM, non-STEM majors in 4-yr undergraduate programs.*

*2: Do life and physical science majors in an emerging Hispanic-Serving institution differ on measures theorized to impact persistence?*

> *Do students differ on measures of academic-based social capital, constructed using items from Stanton-Salazar (2001)?*
>
> *Do students in life and physical and science majors differ on measures of GPA, science identity, and racial campus climate that are theorized to impact persistence?*

*3: What experiences do Latinx students in their 3rd year or beyond in life and physical science students identify as central to persist?*

> *What institutional supports were identified as important for persistence, and who did Latinx students draw these from?*
>
> *How are students negotiating home and school networks to access resources to persist?*

Answering the first research question involved performing a secondary analysis of a national dataset. Using items previously used to predict academic achievement as outcome of social capital (Ream, 2005), these items were first examined to identify underlying factors with other items that similarly theoretically aligned with social capital, such as volunteering in the community, engaging in intramural sports, or seeking formal counseling. Then, these social capital items were used to predict 1-yr and 2-yr persistence, and if differences existed between students in different majors. This was performed by using a binary probit ridge regression.

To answer the second and third question, a mixed-methods study was used that consisted of a designed survey and semi-structured interviews. Surveys were used to answer the second research questions, while semi-structured interviews were used to answer the third. Survey data were analyzed using a ridge regression performed on six models of outcome measures theoretically connected to persistence, including social capital, racial climate, GPA, and science identity. These models were used to if differences existed between students in different majors, an if background characteristic could explain any differences in measures of factors theoretically believed to impact persistence. Semi-structured interview data (Saldana, 2013) were analyzed using a hybrid coding scheme (Saldana, 2013), using initial, a priori, pattern and thematic coding to identify key institutional supports that Latinx participants in life and physical science drew upon to persist, as well as how they negotiated their networks to minimize negative impacts while accessing key supports. First, evaluation coding was used to explore the importance attributed to persistence using institutional supports, followed by pattern coding to identify a subset of themes attributed to persistence by students (Saldana, 2013), with the aim of outlining similar themes among all participants, and those in life and physical sciences.

**Findings and Discussion: Research Question One**

*1: Does social capital predict 1st and 2nd year persistence for first-time physical science, life science, social science, other-STEM, non-STEM majors in 4-yr undergraduate programs.*

This section outlines the findings for the first research question of this study, by analyzing data from a secondary analysis of the NELS 88:00 dataset. An exploratory factor analysis was used to examine if new items measured the same underlying constructs as items of social capital used in previous research, most notably the work of Ream (2005). Then items were used to predict effects of social capital. In addition, other dimensions that have been previously shown to influence persistence, such as higher education status, educational expectations, negative social capital, and among group status like major, gender, and race/ethnicity were included in the model. Propensity scores as covariates were used to identify any baseline differences between measures that would explain differences in persistence (Rubin & Rosenbaum, 1983, Woodcock et al., 2013), as students initially enrolling as science majors on average have higher high school academic achievement and performance than their non-science counterparts (Chen, 2013; Seymour & Hewitt, 1997). Interaction effects were also added as past research has identified differing outcomes in persistence between students of different race/ethnicities, and gender (Chen, 2013; Espinosa, 2011; NSF, 2014; Ong et al., 2011, 2018; PCAST, 2012; Seymour & Hewitt, 1997).

For the factor analysis, only one new item that was theoretically thought to align with items form Ream (2005), did extract onto these measures of social capital. In addition, as a procedure for variable reduction, this approach would have reduced the 60 items inputted to 23 items, but only accounting for 32% of the variance in measures. These five extracted factors aligned roughly to the four sources of social capital identified by Ream (2005). These previously identified sources included social capital among families, peers, school, and community.

Extracted factors aligned with social capital among families, peers, and community. Three of the extracted factors aligned with the multiple dimensions of social capital among families, with two factors aligning with parent/sibling involvement in student's education (labelled as categories 1a), and one factor aligning with parent-student bond (labelled 1b). Another factor aligned with social capital among peers, specifically around student's prioritization of education (2c). The last factor aligned with social capital within communities, and specifically the dimensions around religious participation (3b).

This factor analysis both reinforces the use of these items as social capital, but also raises questions. The alignment of these items with previous research is consistent with previous work on social capital (Dika & Singh, 2001; Ream, 2005). Still the reduction to approximately one-third of the original items may be indicating misalignment of social capital items from the baseline year 1988, to 2000, the last follow-up survey. This would suggest an inconsistency in social capital over time. Yet, this may only be for certain dimensions of social capital, as religious participation, the one new item that aligned with old, did show consistency over time. Factor analysis usually leads to removal of items from analysis, as an approach to variable reduction. Yet, as ridge regression corrects for multicollinearity, there was no reason for performing variable reduction, and all items were included in the secondary analysis models.

The secondary analysis examined both 1-yr and 2-yr persistence of students based on dimensions of social capital, major, race/ethnicity, educational expectations. Two major findings from this analysis arose: (a) social capital has a greater predictability for 2-yr persistence than 1-yr persistence, and (b) there exists baseline differences that affect the persistence of students from different science major fields. These two findings will be discussed below.

The 2-yr persistence models explain more of the variation of persistence than the 1-yr models. The 2-yr models accounted for approximately 82% of the variance in persistence, while the 1-yr model only accounted for approximately 55% of the variance, with both no interactions and interactions models accounting for approximately the same variance in persistence. This suggests that social capital may be more important for students to continue in their major, to the second year, versus persistence associated with selecting a university or major that are good 'fits' for students (Tinto, 2012). While the exact reason is uncertain, Rios-Aguilar and Deil-Amen (2012) note the differing utility of social capital students have, when comparing social capital from before entering high school compared to social capital in higher education. Still, as most measures of social capital in this study were from the survey when students were in HS, this would suggest that this social capital does have an impact beyond enrolling into post-secondary institutions. As mentioned earlier, the social capital items in the 1-yr model that predicted persistence appeared to involve student agency rather than that of the parent. Yet, the 2-yr persistence models were better fits than the 1-yr models, while not having the same significant items that were related to student agency. This suggests that previous social capital is important for persistence, but how it manifests as support to persist is unclear. Further research examining how new and old networks are negotiated by students to access resources can help clarify this.

Differences in 1-yr and 2-yr model fit may also be related to factors that are not social capital. These include effects associated with the transition into a new schooling environment, that may not be fully explained by social capital. For example, post-secondary education often involves integrating into a new set of norms and practices that may not be similar to their own (Tierney, 1999; Tinto, 2012), negotiating home and school responsibilities (Guiffrida, 2004, 2005), campus experiences that build connection to campus (Astin, 1999) and the major (Chang et al., 2011) or negotiating a negative campus climate (Cabrera et al., 2016; Chang et al., 2011; Solórzano et al.; 2001). While this research field is established, examining this transition specifically for a narrow band of science majors or fields holds promise for expanding on this research, and few studies examine causal effects, as was done using propensity scores in this study and others (Schultz et al., 2012).

Persistence of students in different majors also varied across all models, with baseline differences existing between some majors. In models without interactions, the 1-yr persistence mode had life science majors more likely to persist, while other and non-science majors were less likely to persist. In the 2-yr models, life, physical and social science majors all had higher probability of persistence, and other science and non-science majors were again predicting lower probability of persistence, with the propensity score for other science majors also significant. This suggests that social capital has a greater impact among life, physical and social science majors to be mobilized to persist than for non-science and other science majors, as they had greater persistence based on social capital items.

Still, as the propensity score for other science majors being significant, this indicated that other science majors had baseline differences with reference to persistence based on social capital, when compared to the four other major fields, and so should be interpreted cautiously. While other science majors did not have lower persistence in this social capital model, there may be differences if more students with statistically insignificant differences in social capital are compared. This may be capturing the wide variation in persistence among different majors in the 'other' science category, most notably high attrition rates among computer science (Chen, 2013; Ferrare, & Lee, 2014; Seymour & Hewitt, 1997). A deeper examination of the other science category holds promise to understand the particular issues these students face, and is also pertinent to engineering fields, which, like science fields, vary greatly in content and performance of science. With computer science an increasingly focal part of the department of defense of the United States, this remains a vital area of study (NAE-NRC, 2012). This may also hold particular interest to multiple stakeholders, such as the US government in addition to institutions of higher education.

This supports some of the literature that indicates differences in persistence rates for students in different majors. Seymour & Hewitt (1997) indicated that life science majors had the highest rates of persistence to graduation and chemistry, a physical science major, the lowest, while Chen (2013) indicated that both life and physical science majors persisted at higher rates than other majors, in or out of science. This supports Chen's (2013) findings, but historical differences in persistence between Chen (2013) and Seymour & Hewitt (1997), and in graduation rates at UNIV, suggests cohort level impacts may also impact persistence. Additionally, with such a wide gap between studies, cohort year may be an effect that should be more closely considered and reported in comparisons. Additionally, with non-science majors in 1-yr and 2-yr models, this is expected, as the undecided students were also caught in this category, but their inclusion also indicated that the selection of major, as undecided or not, was not dependent on social capital, as others have suggested (Simpson, 2001).

When interactions terms were added, majors again had an impact. In the 1-yr interactions model, male, non-science majors had an increased probability of persistence, while API-non-science majors had a decreased probability of persistence. In the 2-yr interactions model, non-science majors, and interaction terms of Latinx-life science majors, API-physical science majors, API-other science majors, and Black-social science majors had increased probability of persistence, while API social science majors had a decreased probability of persistence.

There is some debate as to how to interpret interaction terms in regression models, as there are two competing viewpoints. This study takes the position that these interaction terms should be interpreted in the absence of main effects. This is the approach that Jaccard & Turrisi (2003) suggest, with disordinal interaction terms interpreted without main effects. As binary variables, race/ethnicity, gender and major interactions will all be disordinal in this case. This interaction effects supports views of the 'double-bind,' with gendered effects related to persistence for URM students (Ong et al., 2011).

This 'double-bind' view that URM women as doubly disadvantaged is seen in outcomes among the race/ethnicity, gender and interaction effects. In the 1-yr model with interactions, only interaction effects with major, and not main effects of major, were significant. These increased probability of persistence for API-male, and Latinx-male students, as well as a decreased persistence for White-male students. This contradicts much of the literature with gender and race/ethnicity and persistence, as White and Asian male students are often used as reference groups, because of their higher rates of persistence than other groups. For 2-yr API-male, and Latinx-male again had increased probability of persistence, while Black-male students now had lowered probability of persistence. Some studies suggest that this initial year persistence may be because of the relatively high academic achievement of URM students at 4-yr institutions, given the history of inequitable education in the US, that also explains the higher rates of URM males in STEM (Cabrera, Nora & Terenzini, 1999; Riegle-Crumb & King, 2010; Oakes, 1990; Tate, 2005). This also suggests continuing this examination up to 6-year persistence to degree attainment as a way to identify consistent effects from year to year. With main effects for majors diminishing from 1-yr to 2-yr models, it is possible that intervening factors exist that can explain the lack of main effects as prominent predictors.

Alternatively, it is possible that there are programmatic aspects to majors that no longer impact students in later years. For example, previous studies have noted the importance of math preparation for persistence of students into higher-level STEM courses (Ellis, Fosdick, & Rasmussen, 2016; Kost, Pollock, & Finkelstein, 2008; Ost, 2010; Shapiro & Sax, 2011), but these may be resolved by the later years of study through coursework, or academic supports. Additionally, since even high-achieving students, particularly women, leave STEM majors because of perceptions of competence in STEM, those students who do persist may not be making decisions to persist as connected to this competence. Further examination into the math histories or narratives of students who persist in differences STEM fields would help elucidate this, particularly since most past research on math ability focused on early measures or counted math courses taken (Maltese & Tai, 2011; PCAST, 2012). Still, there is wide breadth of math requirements between majors, with life science majors tending to require less math, and physical science and engineering programs requiring more math coursework.

The NELS models also provided insight in thinking about social capital impacts on students' persistence, and three insights can be gleamed from this. First, social capital within families, within community, and among peers were all significant, suggesting that social capital is important for understanding persistence, but that a deeper understanding of how social capital manifests over time is important. Second, negative social capital, college experiences and educational expectations have unclear impacts on persistence, suggesting an area for further study. Lastly, while categorized under social capital within communities, religious affiliation and activities consistently predicted persistence, and attending with parents, negatively. This suggests that some effect of social obligation instead of for desired socialization is important to examine.

With respect to social capital within family, community and peers, multiple items predicted both positive and negative probability of persistence. As the exploratory factor analysis noted, this may be because of items loading onto different constructs, and so potentially multiple impacts are being captured here. This also provides quantitative support to Guiffrida (2004) and Ceglie & Settlage (2015) that note the tension between family and peers, as supportive or detrimental are captured in the differing supports that they provide.

These conflicting effects suggest deeper examination of the role of social capital on persistence. This can be seen around parental involvement and social capital within families, where items associated with students' agency, rather than parents, more often positively predicted persistence, suggesting that too much involvement by parents before college may be leading students to not develop ways of cultivating their own social capital, similarly seen when students with strong social capital fail to do well because of dependence on social capital outside of higher education institutions (Person & Rosenbaum, 2006). Still, there are noted advantages that can be transmitted through involved parents (Lareau, 2003). Similarly, this development of social capital can explain why negative social capital may initially positively predict persistence, but over time negatively predicts persistence. The supports that helped students enter higher education in spite of the challenges they faced, are not the same as those needed to continue beyond college entry (Deil-Amen & Rios-Aguila, 2012). Still, little work has looked at negative social capital in relationship to STEM persistence, so it is difficult to pinpoint why this phenomenon may be occurring.

In examining social capital among peers, having a shared academic orientation towards academics, which included such measures as continuing education past HS and the importance of engaging in studying, was important for persistence. Engaging in activities that providing services for others was negative. This was consistent with research that highlights the importance of expectations and peer interactions oriented towards academics and not to other activities that can pull students away from academic pursuits (Cole & Espinoza, 2008; PCAST, 2012). The exception to this was the importance of receiving good grades item, which theoretically aligns with positive academic expectations, but negatively predicted persistence. These results are consistent in the 2-yr models, where high academic expectations increasing probability of persistence, with receiving good grades still negatively predicting persistence.

This focus on grades has been seen to be an issue influencing attrition among women, as impressions of grades are important for views of competence in the fields, particularly among women. Seymour & Hewitt (1997) highlight how women that may be outperforming their male counterparts leave STEM fields because of the inconsistent feedback on their performance, rather than their comparative performance to others. In past research, receiving poor grades, that would be 'curved' higher acted as inconsistent messages on competence. Doing well relative to others though differs from individual conceptions of competence and was important for persistence.

Social capital within schools may vary as students transition to and through higher education. Among social capital within schools, formal supports positively impacted 1-yr persistence, while external influences, like parents and teacher's expectations, negatively impacted persistence. The formalized supports may highlight the ways in which help-seeking by students is more important than the intervention of others in accessing resources to persist. In addition, this may be indicating the development increased autonomy and the importance of agency as students engage in higher education as opposed to high school (Rios-Aguilar & Deil-Amen, 2012; Stanton-Salazar, 2001). The differential benefit of social capital based on context as raised by Rios-Aguilar & Deil-Amen (2012) means that the items like favorite teacher of teen finding it important for student to go to college, may be capturing the expectations and direct supports that allow for students to be successful academically and, thus, increasing the probability of persistence (Chang et al., 2011; Camacho & Lord, 2011; Strayhorn et al., 2013). This would explain why from the 1-yr model to the 2-yr model, this item changes from negatively predicting persistence to positively predicting persistence.

Among educational expectations, one item similarly seemed to contradict the others. Expecting to continue study beyond high school, and expected occupation at 30 being science related, were measures that consistently increased probability of persistence in all models. Yet, a similar item, expecting to have a science occupation in the future, decreased probability of persistence. The positive impacts of expectations are often interpreted as a proxy for motivation to persist in science, with motivation supporting academic achievement and achievement predicting persistence (PCAST, 2012). Yet, this too is unclear, as entering STEM fields based on parental expectations rather than individual motivations and aspirations is a major reason why students leave STEM fields (Seymour & Hewitt, 1997).

Other higher education items may also be indicating social capital's positive effect on persistence. Formal supports, formal tutoring, counseling, or receiving specific instructional math and science instruction all provided increased probability of persistence, when significant. Still, other higher education experiences, including taking science coursework, and other, nonacademic experiences, like participating in student government, all decreased probability of persistence. Tinto's (2012) model, of persistence as attributed to socialization, posits that increased socialization helps with persistence, and other similarly explain persistence, such as Astin's (Astin, 1999) I-E-O model, basing outcomes for students as based on their individual characteristics and dispositions and their experiences within the higher education institution. Since the models run in this study are measuring persistence in initial major, it is still possible that students are persisting within the institution, but not within their majors, and these outcomes are not captured, but could be further area of examination.

Nonacademic experiences, such as engagement in clubs, or intramural sports, negatively predicted probability of persistence. This identifies a tension between developing a sense of belonging on campus through relationships that may not be academic oriented, and has been highlighted by others (Chang et al., 2011; Cole & Espinoza, 2008), but may also be establishing a pull-out factor (Crisp & Nora, 2010) of an academic major rather than a push out due to negative experiences. Continuing to be enrolled in the first post-secondary institution means that students were persisting in the same institution to the 2$^{nd}$ year, and so it is not a surprise that they may also be changing majors as instead of changing institutions as a response to push/pull effects. Future analysis should examine if measures like engagement in clubs, or sports are mediating or intervening effects on persistence, through path analysis or SEM.

A similar effect was seen in family support through non-academic pursuits as decreasing probability of persistence. As noted, scholars have indicated the role that family can play in pulling students away from academics (Crisp, Nora & Taggart, 2009; Guiffrida, 2004, 2005; Oseguera et al., 2008; Seymour & Hewitt, 1997). This distinction was less clear as connected to developing student agency in the 2-yr persistence models as it was in the 1-yr models, suggesting that family based social capital may better attend to the issues students face in the transition from high school to college, but not as much for persisting beyond the 1$^{st}$ year, the difference between 'getting through' and 'getting to' college (Rios-Aguilar & Deil-Amen, 2012). The focus on academic based activities as supporting student persistence though, does suggest that the development of cultural capital should be explored further, with consideration of developing cultural capital that allows for resistance to hostile environments experienced by URM and female students in STEM (Archer et al., 2015; Revelo & Baber, 2017; Revelo Alonso, 2015).

For social capital within community, most items reduced probability of persistence, except those of religious activities and religious services with parents. Literature on religious association in higher education, particularly among URM students, highlights these experiences as providing places of coping and support and building community. This occurs in ways that where spaces act to build cohesion between students, acting as counterspaces, or a place of resistance, to others (Ceglie & Settlage, 2015; Ong et al., 2018). Religious activities have also been shown to provide spaces for building community among college students across racial/ethnic groups (Park & Bowman, 2015), and at younger ages, in promoting academic progress (Salas-Wright, Lombe, Vaughn, & Maynard, 2016). Research examining the role of faith and religion in the persistence of students in STEM should be examined. This is important as emerging research examining the role of religiosity and acceptance of science (Evans & Feng, 2013) allows for distinguishing between the social capital they offer. This research can allow for comparison of socialization into norms, beliefs and practices that affirms cohesiveness of networks or is instead used to cope an persist with hostile networks (Ceglie, 2013).

Still, the mechanism by which this occurs is also unclear and has differing impacts on students from different racial/ethnic backgrounds. The centrality of religion to the academic experiences of students is also unclear, as we as how religiosity is affirmed in practice, particularly among scientists is unclear, but recent research has shown that higher levels of religiosity predict lower levels of STEM scores internationally, when measured on TIMSS and PISA scores. With organized groups, like religious groups, there is always a tension between individual and collective identity as well as negotiating in and out groups in reference to these dimensions (Gadotti, 1996, Stets & Burke, 2000). This tension may help identify how students position themselves to access social capital or to be used as counterspaces. These results of positive effects from religion were consistent with 2-year persistence models, although sports also positively predicted persistence, possibly as it similarly has potential to build community as religion does.

With respect to taking science courses decreasing probability of persistence, given the 'gatekeeper' classes often associated with STEM majors, taking science courses may be what pushes students out of these fields. These science courses are often viewed as "weed-out" classes (Gasiewski et al., 2016; Malcom & Feder, 2016; Seymour & Hewitt, 1997), classes that are unnecessarily difficult to push academically unprepared students out of science. They are likely to be poorly taught and to alienate students (Espinosa, 2011; Gasiewski et al., 2012; Malcom & Feder, 2016; PCAST, 2012; Seymour & Hewitt, 1997). Moving away from TA's teaching these courses and towards engaging students rather than 'weeding them out,' works to increase positive experiences with these gatekeeper courses (Gasiewski et al., 2012; Seymour & Hewitt, 1997).

Lastly, with respect to negative social capital in the 2-yr persistence models these covariates reduced probability of persistence, signaling negative impacts from these associations (Portes, 1998). These associations also possibly pull students to acts as resources for supporting family or peers off-campus (Guiffrida, 2005). Yet, the 1-yr models had death in family and being or someone close to participant being arrested, as increasing the probability of persistence. As there is no disambiguation between whether it was the student or friend that was arrested, nor the proximity or importance of family to the student's education or home life, it is unclear how this impacts students. Even then, this does not consider the nature of the relationships had with those infirmed or deceased, with some associations positively negatively, or pulling away from academic studies, while others may promote persistence.

**Findings and Discussion: Research Question Two**

*Do life and physical science majors in an emerging Hispanic-Serving institution differ on measures theorized to impact persistence?*

> *Do students differ on measures of academic-based social capital, constructed using items from Stanton-Salazar (2001)?*

To address the second research question, a designed survey was used based on more recent social capital measures, modelled after items developed to measure social capital (Stanton-Salazar, 2001). These items were used to examine the social capital students identified from various sources, faculty, family, and peers. Additionally, this study examined the science identity, sense of belonging, and campus racial climate of students, as these measures have also been shown to influence persistence or academic achievement, a mediating factor for persistence. These measures also speak to the contextualized experiences of students, as well as to the tensions that students feel existing between networks as science majors and captured in their science identity. Agency to align or counter perceived group science identity, explains how science identity manifests as network development. The mechanism for this, through participants having a sense of competence, through the performance of science practices, and being recognized by scientists to be a scientist (Carlone & Johnson, 2007; Chang et al., 2011) are the dimensions in which science identity can be affirmed or disrupted. Lastly, the survey captured an overview of how students in different majors compare on these measures, as well as a method of comparing URM students based on measures that predict persistence.

The significant models accounted for between 21% and 31% of the variance in outcome measures. The peer social capital model accounted for 31% of the variance, family social capital model accounted for 21% of the variance, and GPA model accounted for 31% of the variance. In answering this research question, for all models, major did not significantly affect any of the outcome variables, suggesting that at least for UNIV students, they did not differ on measures of social capital because of major. These models will be discussed in turn, grouped by those that are social capital from Stanton-Salazar (2001), and those that are not categorized as such.

**Social capital measures.**

Among social capital measures, the mode for peer social capital explained more variance than the model for family social capital, and faculty social capital was not significant model. In the two social capital models that were significant, female students are the only demographic group significantly different than others, having higher measures than men. This is supported by research that shows women having positive peer interactions as key for women to persistence (Ong et al., 2018).

Other predictors that affected peer social capital included preferred language usage and having close friends outside of UNIV. Both negatively impacted peer social capital measures, suggesting that dominant language usage can a barrier to forming peer relationships. This also suggests that having close friends outside of the UNIV comes at the cost of peer social capital on campus but may be necessary to maintain group cohesion centered around language outside the university, particularly among immigrant groups. This suggests an examination of students' socialization within and outside of school contexts where foreign languages are commonly spoken, to assess how language availability and language usage can influence socialization into or out of science spaces or among science peers.

There also appear to be conflating variables around family and peer social capital. Since family recommendations and staying close to home both positively predict for family and peer social capital, this finding may be showing the overlap between networks. Past research has indicated that family and peer cohesion is particularly strong among Latinx students, where social capital guides enrollment decisions in order to have established networks on campus once students arrive (Perez & McDonough, 2008). Similarly, Cole & Espinoza (2008) also note that like family, peer relationships can be both positive and detrimental to academic achievement.

Findings support this happening among the UNIV sample, as the item family recommendation for attending and staying close to home negatively predicted persistence for GPA, but positively for peer and family social capital. This also suggests a more purposeful analysis of how peer and social capital may be aimed at capturing similar underlying constructs in support, but different by source. For example, students that chose to come to UNIV because of academic or other support programs, had higher measures of peer social capital. This finding is supported in the literature that identifies these programs as sources of social capital, and places to develop networks with peers and faculty (Estrada et al., 2017). This suggests that where students are centering their close friends, whether in, or out of school, or some combination thereof, influences the development of peer social capital.

**GPA, science identity and racial climate.**

For GPA, a measure of academic performance that predicts persistence for all majors (Pascarella & Terenzini, 2005), lower GPAs were found for those identifying as male and those identifying as having Hispanic ethnicity. This suggests that there are effects on students' performance along dimensions of gender or race but is contradicted by the lack of significance in the racial climate model. Lower male academic achievement and Latinx achievement though is consistent with the literature (Arbona & Nora, 2009; Contreras & Gandara, 2009).

Peer interactions matter with respect to GPA but differ depending on location of close friends. Those students that chose UNIV in order to stay close to home or because of family recommendations, had lower GPAs, but also higher measures of positive peer social capital. As mentioned in the previous section, past research suggests that maintaining relationships outside higher education can be detrimental to academic success, because of familial responsibilities. Peer social capital is higher among those that give importance to staying close to home or because of a family recommendation to attend UNIV. This suggests that these students seek support from peers on-campus to account for supports they cannot access form peers off-campus of UNIV. Additionally, the importance of the low cost of UNIV as a reason for attending UNIV as a positive predictor for GPA suggests that as Oseguera et al. (2008) indicated, financing school is important and without ways to pay for school, students may be pulled to work to pay for school.

With respect to GPA, peer social capital should be considered. This study found that peer social capital was predicted by gender as well as language preference, and raised questions about how male, and Latinx male students are perceived on campus due to their lower peer social capital and GPA respectively. With close friends at UNIV having higher measures of peer social capital, peer associations may be mediating GPA. As mentioned earlier, this is supported by Cole & Espinoza (2008) who note that peer interactions are not equal, with some acting as to socialize students into the higher education environment, while others drawing students away from academics. These findings are supporting group cohesion as influencing peer social capital along dimensions of race/ethnicity, gender and language usage. While ethnic group cohesion in counterspaces may provide positive benefits to belonging (Solórzano et al., 2000) social interactions outside these spaces may be necessary to counter a negative climate (Samura, 2016;

Yosso et al., 2007). These spaces then act as both supportive of students belonging, but also act as barriers to peer social capital. Investigating in more detail how counterspaces, both in science (Ong et al., 2018) and focused on racial/ethnic identity (Solorzano et al., 2001; Yosso et al., 2007) promote or hinder the development of peer social capital in STEM should be further investigated. Additionally, science identity can help explain how students make sense of pressures like discrimination that necessitate counterspaces within science networks and campus spaces.

The lower GPA and peer social capital among males is also a concern, and Cabrera, Razshwan-Soto, & Valencia (2016) note that there have been increasing success of female students in accessing and achieving higher education over time relative to males, particularly among URM students. They also note that should URM male students access higher education, they still must contend with a racialized environment, as they cite research that indicates Latinx men experience greater stressors on campus than White men. They attribute this to differential privilege in how URM men's intersectional identities are performed and perceived on campus. This supports the conclusion that identity markers matter, because of how students socialize on campus. Still, research on URM males in higher education is an emerging field. Key to this work is to tease apart inequitable pre-college preparation, from disproportional risk-factors from socialization affecting attrition or not seeking to enroll in higher education (Saenz, Ponjuan, & Figueroa, 2016).

**Models that were not significant.**

Social capital among faculty, racial climate and science identity were expected to differ between students in different majors, but the results did not show a difference among students on these measures. This finding is supported by research that finds students initially enrolling in science majors are more similar to each other than non-science students (Chen, 2013; Seymour & Hewitt, 1997). Yet, previous studies identified the impact of science identity and faculty on persistence (Chang et al., 2011; Eagan et al., 2011; Estrada et al., 2016; Griffith, 2010; Hurtado et al., 2008, 2009). Still, this precious research varied in types of relationships with faculty. For some, it was through small classes, but for others, it was through undergraduate research. This finding pushes on this literature to qualify the nature of these relationships, as well as the definitions of what is considered undergraduate research, particular as a survey measure, as the what experiences institutions classify as undergraduate research varies (Beckman & Hensel, 2009).

Racial climate in particular was expected to be significant. Racial stigmas, and racialized experiences, have been shown to be important for persistence in STEM majors (Chang et al., 2011; McGee, 2015; Strayhorn et al., 2013), but it is possible that students may be downplaying race/ethnicity identity in science majors. This means they may be positioning their science identities to be central, and protective of other identities (Settles, 2004; Settles et al., 2016), or may be dismissing their racial identity (McGee, 2015). Alternatively, this insignificant model could have emerged as UNIV's status as a minority serving institution, and an emerging HSI at the time of this study positioned it to have less racial tension than at primarily White institutions (Cabrera et al., 2016).

**Findings and Discussion: Research Question Three**

*3: What experiences do Latinx students in their 3rd year or beyond in life and physical science students identify as central to persist?*

*What institutional supports were identified as important for persistence, and who did Latinx students draw these from?*

*How are students negotiating home and school networks to access resources to persist?*

To answer the final research question, six self-identified Latinx students in physical and life science majors were interviewed to explore how institutional supports—direct, integrative, system linkage/network development or system development—helped them persist to their 3rd year or beyond in science. These interviews were also used to examine how students negotiated their networks in ways that maximized their access to social capital and minimized detrimental impacts to persistence or to science identity.

The main findings were that students in life and physical science majors: (a) did not differ in what supports they identified as key, and all additionally required affirmation of their science identity to persist; (b) purposefully sought to minimize negative impacts of accessing social capital; and (c) purposefully cultivated multiple sources of social capital that they deemed key to persistence. The only key difference between life and physical science majors was how they negotiated negative impacts from accessing social capital. These three findings will be examined through the institutional supports participants identified, and how they negotiated their networks to maximize benefits and minimize detrimental impacts. Connections to literature and implications for new research will be interwoven,

**Key institutional supports identified and implied.**

Types of institutional supports identified as key were relatively simple and relatively easy to access. Direct supports were overwhelmingly identified as key to persist, as manifested in advice, academic supports, financial support or guidance. Implied within accessing these supports was a cost, whether personally to their science identity, or through negative experiences that alienated them. This section examines finding a and b as listed above.

Participants were hesitant to mention institutional supports they accessed, like tutoring or faculty's office hours. Instead, students would affirm their identity initially, until speaking about academic or trouble accessing the supports they saw as key. This meant that students initially highlighted direct supports as related to the college-going process first, such as those needed to finance school, transportation to school, and housing. Then participants brought up institutional supports related to their academics and formal agents. These supports roughly fall under the source- peer, family, and faculty/staff. This seeking of multiple sources while downplaying the need suggests an examination of how students conceptualize help-seeking within different science majors and is a direction for future research.

Family was key to all participants. Not only was financing school important, family provided encouragement and motivations to continue studying (Ceglie & Settlage; 2015). Yet family had limits on support, often only to direct supports as most had no experience with higher education. With financing college as a structural barrier among Latinx students (Oseguera et al., 2009) and particularly undocumented students (Rodriguez, 2010), these resources were key for students. While Stanton-Salazar (2011) may not note these as institutional supports, as they are not mobilized by agents that have relative high-status in institutions of society, these supports are key to persistence and allows for students to counter stratification. This is best captured in the example of Catalina, an undocumented immigrant student who was a mother of a child under the age of two at the time of our interview. As social structures, such as financial aid restrictions, prevented her from accessing funds for her education, money and childcare are as important as guidance to ways of funding her education as an undocumented immigrant. This helps add to the literature on how students' academic needs are second to more pressing needs, an increasing issue among college students around issues like food access (Cady, 2014).

Participants also raised academic supports as key but emphasized multiple sources of support. Participants noted peers, especially older peers, faculty, and formal tutoring staff (through tutoring centers or programs) as key. Still, many saw the need to justify their use of this direct support. Maria captures this in her description of not wanting to take accommodations for her dis/ability, and the struggle that is was for her to do so. At the heart of the struggle for her was what accessing direct supports or tutoring meant to her competence in science. Raina emphasized this by indicating that the field was only for those that are the best at school, and like Maria saw accessing her accommodations as also them as reducing her competence. While not the focus of this study, accommodations as a form of direct support drastically increases the chances of persisting to graduation but is sought by students in college by only about 40% of those students that accessed them in high school and is a particular problem in STEM fields (Newman, 2005; Newman & Madaus, 2015). This is indicative of how science identity is used by students to mitigate any damages from negative experiences to persist (Carlone & Johnson, 2007), and also a question of how race/ethnicity, gender and other intersectional aspects of identity matter or are discounted (McGee, 2015; Settles, 2004).

Indeed, resisting the access to resources while still using resources was a strategic decision to affirm identity. This was best captured by Angelica, who continued seeking multiple advisors, from multiple departments to affirm her desire to continue on her journey to medical school, even if it required post-baccalaureate education, and persisted in spite of bad advice, that led her to schedule classes for which she was not prepared. Still, finding an advisor that affirmed her path provided a way to affirm her science identity (Carlone & Johnson, 2007), and crystalized her decision to persist, instead of potentially moving to other majors, or seeking some other employment. This raises implications for the examination of students accessing graduate education particularly URM and women students that are desired in larger numbers (Chapa & De la Rosa, 2006).

Advice was key, as it helped students navigate through a new context to reach their vocational goals, affirm their identities through performance of science, or reach their vocational goals. For example, Eduardo did not identify much with science, but instead saw it as a means to an end. As such, he sought the most efficient path "through," and followed advice to affirm his path of a science identity in how he conceived it (Stets & Burke, 2000), and adds to the research on science identity and persistence (Carlone & Johnson, 2007). This affirmation of science identity in its multiple possibilities captures the importance of students' agency in persisting. Particularly with Eduardo, and Catalina, their science identities pushed on traditional conceptions of science identity that suggest further examination into how students are conceiving of their science identity relative to what they perceive in their study of science, particularly along dimensions of science performance.

The overwhelming use of direct supports was also captured in the analysis of initial coding, where life science majors were more likely to indicate direct supports were important for persistence over physical science majors (90% to 68%). Both groups still raised direct supports significantly more than the others, and integrative supports, that capture mentoring and guidance to other mentoring, as second most common, and similar to the direct supports identified.

**Negotiating networks to persist.**

While the institutional supports accessed by participants were quite simple, the ways in which they negotiated their networks was significantly more complex. In particular participants discussed how they negotiated family and peer networks in ways that helped facilitate their persistence or minimize chances of attrition. For life science majors, this often meant seeking alternative spaces, or sources of support when confronted with hostility or discrimination, while for physical science majors, this was perceived as part of being a scientist, and was the only key difference between the two groups.

Faculty were seen as helpful but accessing them was interpreted as detrimental to science identity. Similarly captured earlier in the examples of Raina and Maria, Corey sought to navigate these benefits through drawing on faculty for research and working with faculty as the vice-president of an earth science club on campus. Yet, when he heard the different nature of the relationships that one of his friends had, he reframed his relationships with faculty, and even noted that his research advisor was busy as a department chair, and when he had a 'chilly' interaction with the faculty sponsor of his club, he thought nothing of his detachment, as he sought to affirm his science identity in this field, as he desired to enter graduate school. While Peralta et al. (2011) and Strayhorn et al. (2013) highlight the power of peer academic collaboration for persistence, here informal interactions are used to assess the quality of faculty-student interactions. While Corey's response is to find a counterspace to cope, this reveals how networks are accessed for their resources. Corey used peers to assess a faculty connection. This expands on Guiffrida's (2004) work where students break ties with some peers that are viewed as liabilities. This idea of purposeful reassessment of peers to purposeful assessment of relationships to persist, is another avenue for future research.

Additionally, Corey sought the music department because family could not be a counterspace for him. Corey explicitly stated that his references to science phenomenon or science content at home were seen negatively and alienated him from family. Unlike McGee (2015), Corey had to contend with affirming his science identity or ethnic identity at home, rather than at UNIV. Davidson, Yu, & Phelan (1996) described how alignment between home and school 'worlds' help students succeed, and Tinto (2012) similarly notes this as a reason that

White, middle class students tend to have better outcomes than others. An examination of other 'worlds' of students, how aligned their home and school culture is, particularly in STEM holds promise in understanding how students contend with tensions that exist.

Conversely, as mentioned earlier, Maria spoke of the challenge it took to confront the "silly" view that had framed accessing accommodations as a loss of competence. Having parent's that studied science would normally be an asset to succeed in science, but Maria felt she could not discuss the tension felt around accessing accommodations, as this ideology was implied when her mother would encourage Maria to change majors, a condition of her offering advice.

Yet, Maria would not seek advice or academic help from her parents, even though they could provide this advice because it was coupled with a push to leave science from her mother. This meant that Maria assessed the benefit of seeking supports and demarcated what type of institutional supports she would seek from her mother. Examining more closely how Maria decides to seek supports from her parents' experiences could help highlight how she contends with missing alternatives to supports, or how she is deciding if the benefits outweigh the push to leave around particular decisions.

Angelica went a step further than Maria in decrying the 'chilly' climate as unnecessarily created by staff. She highlighted an incident where she felt she was in "Fight Club" to a comment an instructor made, the cliché statement of looking to the left and right to your peers, to visually see that only a small percentage will make it to graduation. Even though this was but one of many negative experiences, she expressed the inability to seek refuge at home, as her mom and other family placed obligations on her that made it difficult to focus her time on her academic work. Yet, Angelica persevered, through an affirmation from a counselor that entering medical school was still a possibility, but requiring an alternative plan, as she could not directly enter medical school with her current academic performance.

Catalina, like Corey, another physical science major, saw this competitiveness as endemic to the major, and moreover, regarded it as emphasizing an elitist attitude and perception of scientists in a way that conflicted with her own science identity. This was captured in her interactions with community members she sought to be of service to through environmental justice activism, as an extension of her current community organization work. This emphasized that her perception of others in her science classes, as well as her perception of her science major classmates as elitist, was similarly felt by others outside the institution. This emphasized her desire to leave the major, because she could not reconcile how she wished to enact her science identity and how it was being perceived by others.

Threaded within decisions to leave, like Catalina and Raina, or to stay when contending with hostility from peers, staff, and family, like Angelica's decision to persist given her relatively low performance level (zGPA=-1.049), is the agency to affirm identity and purposefully work to do so. Building on past science education research (Morales-Doyle et al., 2018; Varelas et al., 2018), this identity and agency, and the interplay between the two, is a developmental process. Longitudinally examining how students are conceiving of their science identity, and their decisions to persist or leave, extends this work. This would also extend current research beyond statistical models of tracking outcomes, to how students are making sense of the process. This is important in the cases of both Raina and Catalina, both who are switching majors, and both to affirm their vocational goals- one as a forensic pathologist and the other as a science teacher. For Catalina withdrawal from her major, was because of the misalignment felt by her identity and how she viewed the chemistry field (Stets & Burke, 2000). Catalina emphasized a lack of recognition for her own agency, among others like her dad, inspiring attrition (Godwin & Potvin, 2017).

This also suggests that there is plenty of lag time between negative experiences and choosing to leave a major or withdraw from spaces that can be supportive. Since all participants actively sought new sources of institutional supports when assessing them to be inadequate, this suggest a closer examination of students' well-being within the major, particularly at key times for attrition-within the first two years can help identify issues and rectify them to bring students back from isolation into science networks. Still, Catalina's choice to leave speaks to a deeper problem within STEM, where she was beginning to perceive herself as elitist and antithetical to her desire to affect social change, a desire important to URM students in STEM when compared to their non-URM counterparts (Carlone & Johnson, 2007; Garibay, 2015, 2017).

It also speaks to a missed educational opportunity here to confront what Bang and Medin (2009) refer to as the nature/culture divide in science, where science views restrict integrating natural science with social world (Bang & Medin, 2009). As Aikenhead (2006) noted, traditional or canonical ways of teaching science also do a poor job of preparing students for engaging in authentic science activities outside of the classroom and alienate the majority of students by isolating science practices from the real-world in this way. Estrada et al. (2017), have shown some success in implementing workshops that highlight how students could engage in these multiple practices, bridging this divide and increase student persistence in science.

This suggests a difficult to implement but promising intervention. Support for students in negotiating multiple needs and supports from off-campus networks, particularly among family networks could help student persist. Building on the idea of cultural integrity (Tierney, 1999), and that of community cultural wealth in science (Revelo Alonso, 2015; Yosso, 2005), departments can work to integrate family, or local communities that can affirm multiple applications of science, or even seek to modify curriculum to affirm these applications (Anderson, 2004). Additional supports, like direct supports related to financing student education for students is ideal, if not always feasible. This could reduce the need or burden for students to work, or seek other direct resources off-campus (Oseguera et al., 2008).

Emphasized throughout this section is the need to affirm students' science identities. Past research has noted the importance of counterspaces in doing so (Ong et al., 2018), lest students feel they need to marginalize parts of their identity (McGee, 2015; Settles, 2004, Settles et al., 2018). This affirmation can occur within formal science classes (Anderson, 2004) or programs (Kinkhead, 2003) and would provide a method of validating alternative ways to practice science (Espinosa, 2011; MacLachlan, 2006; Ong et al., 2018). While only a concern for Catalina, this may be a larger issue within the 1st and 2nd year of study within science, where most students leave. Examining how formal spaces can act as counterspaces, through alternative science practices to the cannon are also a direction for research.

**Recommendations for Future Research**

This study contributed to the research on persistence in science, social capital, and science identity. Suggestions for future research along these dimensions are presented, with the understanding that there is much overlap between research in these fields that seeks to address the problem of persistence of students in STEM fields, before outlining recommendations for practitioners.

With reference to research on persistence in higher education, there are a number of recommendations. First, while the NELS 88:00 and other national datasets provide an opportunity for longitudinal analysis, examination of UNIV graduation rates presented differences in cohorts in measures of graduation rates and rates of continuation. Other datasets allow for examination of both longitudinal analysis as well as cohort analysis, such as those from surveys given by the of the Higher Education Research Institute, and of the National Survey of Student Engagement. These datasets provide opportunity to investigate patterns, but like the NELS dataset, were not constructed to explicitly capture social capital. These datasets still provide potential to explore differences in persistence among students in science majors and STEM fields generally.

Additionally, cohort differences could be linked with the larger sociopolitical environment. For example, Catalina was an undocumented student during the runup to the 2016 presidential election. With undocumented immigrants and other foreign students being vilified inn popular media, examining cohort measures of racial climate, sense of belonging, or even enrollment by racial/ethnic demographics, all provide ways to examine this how differences in salient social stratification forces as outlined by Stanton-Salazar (2001, 2011) vary to explain cohort differences in outcomes. Still, the effect of larger social forces on sense of belonging and racial climate is unclear. As previously mentioned, sense of belonging can differ among spaces on campus (Samura, 2016; Soldner et al., 2012), and these can act to insulate students from larger social forces. Still, social reproduction theory suggests that institutions still reproduce inequity (Bourdieu, 1977; Stanton-Salazar 2001). Research comparing larger sociopolitical climate and campus climate could explore this connection and focusing on STEM networks would be particularly insightful. This also includes how peers are interacting on campus, with dimensions of race/ethnicity, gender, or language usage as potential barriers to peer formation.

Further directions for research include overlaps with social capital and persistence research. How students are choosing to engage in different networks should be further studied.

While this study captured where students accessed supports perceived vital to persistence, how networks were purposefully developed, as well as network overlap or density, was not explored, and could provide further insight into availability of supports compared to which supports were actually accessed or spurned. While this study drew on agency to explain student engagement in networks, even hostile networks, a wider examination of networks could help visualize how students seek specific networks or individuals as spaces safe from hostility, while others are necessarily engaged in spite of hostility. A deeper examination of students' networks may be insightful, but possibly intrusive, especially considering the multiple networks in which participants existed and engaged. Still, this may be a first step in learning more about how networks function and are managed purposefully by students to persist.

Additionally, while this study addressed negative social capital, this may more accurately be captured in the tensions that students identify between different sources of social capital. While not apparent in the quantitative analysis, the qualitative analysis highlighted tensions that exist from sources that both support students while also being detrimental. The examples presented by Maria and Catalina exemplified how individuals, let alone networks, can act to contradict the support given. Although Coleman (1989, 1992) speaks in-depth of the transactional nature of social capital, this does not entirely capture the experiences of participants in this study. Norms and practices are negotiated and challenged, rather than affirmed by networks. Participants showed agency to challenge norms like gendered roles in family, and a deeper examination of how individuals in networks act as more than sources of resources. Examining these connections in more depth is the next step in understanding how students decide to make and break network connections to persist. Qualitative investigation is emphasized here as it is quite likely that effects may vary or be measures muted because of participants determine if these mixed interactions are net positive or negative interactions.

These visible tensions also suggest further research is needed to understand how students negotiate tensions within networks. Further exploration into how students are making sense of mixed messages from their networks along with their own aspirations to persist. Related, how students navigate opportunities to reach their aspirations is also key to understanding more about persistence and attrition from science majors. Two students left their major for others that involved aligning more with how they conceived of practicing science, but both would also be considered as failing to achieve science degrees, instead aiming for degrees in social science and criminal justice. Yet, both these shifts aligned more with aspirations of science practices that pushed on more canonical science conceptions, to more applied science. This speaks less of a failure of students to succeed and instead of a narrow view of science. Further study into how students are aspiring to engage in science performance can help highlight the tensions students feel within networks.

Higher education research in science should also investigate difference in programmatic aspects of majors that may lead to differences in persistence. While this study aimed to parse out majors that had dissimilar programs of study, those that were outside the College of Liberal Arts and Sciences, one potential difference noted by participants included that of mathematics requirements. While previous research has identified the role of mathematics preparation of persistence of students in STEM generally as noted earlier, when and to what extent math is required for each major differs greatly, with physical science requiring more math earlier than most life sciences. This may be pushing physical science students to be more engaged in math and science networks earlier because of course requirements but more investigation is required, as advanced placements courses in high school can provide credit for these courses. Alternatively, this could push more advanced students into courses with older peers, facilitating network development or alienation.

With reference to science identity, research further research should explore how students are forming and conceiving of group science identity. This also includes conceptions of competence, and performance in which scientists engage. Archer et al. (2015) note the potential for family and family friends that are scientists to engage students in science norms and practices to develop their "science capital," or cultural capital that is valuable within science spaces. How students are conceiving of science identity, both group and what they aspire to be, varies based on their exposure to "science capital." For some, their exposure to science was normative, while for others it worked to counter canonical conceptions of science. Further research should examine the ways students are constructing their identities in higher education relative to their past experiences.

Additionally, while Ong et al. (2018) notes how science identity can be affirmed in science counterspaces, further research should investigate how students use counterspaces, outside of science, as science majors. This would help identify if these counterspaces help students persist in higher education but pull students out of science majors, as seen with Catalina, or if these spaces help students establish broader networks, such as with Maria. This aligns with past research that has viewed spirituality as important for the persistence of URM women in science majors (Ceglie, 2013), drawing on values, and suggesting that counterspaces out of science are not solely pulling students out of science majors.

Additionally, while past research accounts for race/ethnicity as a component of science identity, how students negotiate multiple aspects of identity should further be investigated. For example, conceptions of competence among students acted as a barrier to accessing academic supports. In multiple cases accessing these supports was seen as a sign of not belonging in science. Other dimensions of identity, including gender and dis/ability also arose as prominent in framing competence, raising questions of how students are managing identities to be most salient for persistence, or as unreconcilable with science identity. Future research should investigate how identity reflects these dimensions. This should particularly investigate whether students draw on identity as a source of aspirations to guide their progress through higher education or as an identity to oppose.

Additionally, with identity dialectically constructed, research should investigate which ‘turning points’ (Denzin, 2013) were most salient for students in conceiving of their science identity as aligning with or countering group science identity. These events or experiences provide insight into the dialectical nature of identity (Torres et al., 2009), but raise concerns about missing out on the everyday affirmation or challenge to science identity, as previous research has identified as part of the ‘chilly’ climate.

**Recommendations for Practitioners**

This study also provides recommendations for practitioners. This study provides recommendations to advisors/counselors, instructors, and faculty on ways to increase persistence for students. Recommendations for practitioners are based on approaches to guiding students in developing social capital to persist or in affirming their science identity. Similar to research recommendations, these overlap as science identity is constructed within networks, and social capital that is relevant to persisting in science exist within science networks.

With reference to advisors and counselors, participants identified advice and guidance that helped students achieve their goals with an understanding of their individual situation. This was the case even if advice guided students to adjust their plans of study. This supports past research that identifies supports as those by institutional agents that seek to empower students (Garcia & Ramirez, 2015; Stanton-Salazar, 2011). Additionally, those institutional agents who used their networks when they lacked the ability to guide students properly (system linkage/network support) helped students develop personalized relationships that helped remove anxiety and instilled confidence, particularly important after negative experiences with advisors as seen with Angelica and Catalina. This suggests that increasing personalization of advisor/advisee relationships holds promise if advisors have established relationships and institutional knowledge for helping students navigate to the supports they need, but that there also must be multiple access to advisors given the possibility of negative interactions. This could mean rotations with multiple advisors for students to identify an advisor for more personalized advising.

Advisors and counselors also serve a pivotal role as having access to networks connections that afford resources for students to build connections to faculty and peers. This includes connections to undergraduate research, specialized tutoring opportunities, academic programs or financial support, as was seen with Eduardo. This is particularly important for students that perceive science spaces as hostile, with students hesitant to engage in faculty-student interactions because of perceptions of that faculty had little interest in students (Seymour & Hewitt, 1997). Advisors here act as "bridging agents" to the resources students need to persist (Stanton-Salazar, 2011).

Advisors and counselors can also act to support students through social-emotional problems. As was seen with Maria with her health and Catalina with her immigration status, meetings with advisors and counselors provide a context for discussing private matters that affect their education. While one ended in a positive experience and the other negative, this again highlights the importance of advisors and counselors in bridging institutional resources and helping develop a sense of belonging or positive climate. Maria continued engaging in multiple networks with multiple advisors, while Catalina never repeated meetings with this advisor nor the academic center to which he belonged.

Although advisors can help bridge students with programs and experiences that help access faculty, faculty can also work to form and bridge these relationships. Although previous literature has identified how changes in curriculum can help connect with students (Aikenhead, 2006; Anderson, 2004; White, Altschuld, & Lee, 2006), it is also important to address the opportunities for students to develop relationships with faculty within the classroom. Previous research has also identified students as conscious of the resources faculty and instructors have for students to achieve and persist in STEM majors (Simmons & Martin, 2014). In addition, learning environments also need be structured in ways to make faculty and instructors accessible to students in order for them to access these resources (Brown, 2005). Still, the with teaching often not emphasized outside of teaching institutions, other responsibilities are often placed onto faculty that count more for promotion and tenure and pushing for changes in curriculum and teaching practices for faculty must also be realistic of the demands placed on them (Griffith, 2010). Faculty and instructors, at the department level can also work to address some of these concerns, as departments afford the ideal size for institutional change within higher education (Kezar, Gehrke, & Elrod, 2013). As noted by Corey, a small department allows for opportunities to connect with faculty directly.

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APPENDIX A

**Appendix A. Items from Ream (2005)**, with additional items from NELS 88 considered pertinent.

*NELS:88* Variables as indicators of social capital
*Social Capital Within Families*
1. *Parents/siblings involved in student's education*

| | |
|---|---|
| student chose school/academic program with parents | F2S12BC |
| parent talked with student about selecting school courses | F2P49A |
| parents influence taking science | F2S18BC |
| student discussed school activities/experiences with parent | F2S99B |
| parent discussed school activities with student | F2P49B |
| parent talk with student about things studied in class | F2P49C |
| parent talked with student about student's grades | F2P49D |
| parent talked with student about applying to school after H.S. | F2P49F |
| sibling influences taking science | F2S18BE |
| sibling helps with homework | F2S26D |
| parent contacted school re: student's academic performance | F2P44A |
| parent contacted school re: student's academic program | F2P44B |
| parent contacted school re: student's after-high-school plans | F2P44C |
| parent contacted school re: college prep course selection | F2P44D |
| parent contacted school re: student's attendance | F2P44E |
| parent contacted school re: student's behavior | F2P44F |
| parent knows which courses student is taking | F2P46A |
| parent knows how well student is doing in school | F2P46B |
| parent worked on homework projects with teen | F2P50B |
| parent encouraged teen to prepare for SAT | F2P62A |
| parent encouraged teen to prepare for ACT | F2P62B |
| parent talked to teen about applying for college | F2P63 |

2. Parent/student bond

| | |
|---|---|
| student does things with mother/father | F2S33H |
| student discussed troubling things with parents | F2S99I |
| parents discussed troubling things with student | F2P49I |
| parents trust student to do what they expect | F2S100A |
| parent talks with student about student's hobbies | F2P49J |
| parent attended movies/plays/conceits with teen | F2P50C |
| parent attended non-school-related sp01ts events with teen | F2P50D |
| parent attended family social functions with teen | F2P50F |
| parent took day-trips or vacations with teen | F2P50G |
| parent worked on hobbies with teen | F2P50H |
| parent went shopping with teen | F2P501 |
| parent went out to eat with teen | F2P50J |
| parent spent time just talking together with teen | F2P50K |
| parent spent time doing something fun with teen | F2P50L |

APPENDIX A.1 (CONTINUED)

| | |
|---|---|
| 3. Intergenerational closure | |
| student's parents know closest friend's parents | F2S97 |
| parent knows parent of teen 's first friend | F2P54B1 |
| parent knows parent of teen 's second friend | F2P54B2 |
| parent knows parent of teen 's third friend | F2P54B3 |
| parent knows parent of teen 's fourth friend | F2P54B4 |
| #of parents teen 's parents talks to with kids at teen's school | F2P55 |
| parent discusses happenings at teens school with other parents | F2P56A |
| parent discusses teen's school plans with other parents | F2P56B |
| parent discusses teen 's career plans with other parents | F2P56C |
| | |
| 4. Parents involved in school-related activities | |
| parent attends school activities with teen | F2P50A |
| parents attend program re : educational opp01tunities after H. S. | F2P45A |
| parent attend program re: college financial aid | F2P45B |
| parent contacted school about doing volunteer work | F2P44G |
| | |
| *Social Capital Among Peers* | |
| 1. Student connected with peers | |
| does things with friends | F2S33G |
| important having strong friendships | F2S40D |
| has friends to count on | F2S67J |
| | |
| 2. Student friendly with other racial groups | F2S7B |
| | |
| 3. Student's friends prioritize education | |
| friends think important to take algebra/math | F2S22BD |
| friends think important to attend class | F2S68A |
| friends think important to study | F2S68B |
| friends think important to get good grades | F2S68D |
| friends think important to continue ed. past H.S. | F2S68H |
| | |
| *Social Capital Within the Community* | |
| 1. Student/parent participates in community | |
| student volunteers in community | F2S37 |
| student volunteers in youth orgm1ization | F2S39A |
| student volunteers in service organization, i.e., Big Brothers | F2S39B |
| student volunteers with educational group | F2S39G |
| student volunteers with environmental group | F2S39H |
| important to do community work | F2S68J |
| important to help others in community | F2S40F |
| parent involved in neighborhood | F2P59 |
| parent believes neighborhood to be safe | F2P60 |
| 2. Student attends religious services/activities | |
| student attends religious activities | F2S33C |

| | |
|---|---|
| student volunteered with church group | F2S39D |
| important to pat1icipate in religious group | F2S68I |
| student attends religious services | F2Sl06 |
| parent attended religious service with student | F2P50E |

*Social Capital Within Schools*

1. Institutional Agent demonstrates caring toward student

| | |
|---|---|
| teachers interested in student(s) | F2S7D |

2. Institutional Agent supports student 's academic advancement

| | |
|---|---|
| teacher helped student with homework | F2S26A |
| important of teacher/counselor in taking algebra/math | F2S22BA |
| school contacted parent about student 's academic program | F2P43B |
| favorite teacher's desire for student after H.S. | F2S41F |

OTHER variables

| | |
|---|---|
| Major/ field of study | F4EMJ1D |
| Gender | F4SEX |

APPENDIX B

## Appendix B. Variable List for items from NELS Dataset.

| Variable Name | Description | Survey | ~ Time in school | Category |
|---|---|---|---|---|
| **lif1_e(x)** | Life science major propensity score-1yr persistence | Derived | | Baseline group comparison |
| **lif2e(x)** | Life science major propensity score-2yr persistence | Derived | | Baseline group comparison |
| **non1e(x)** | Non-science major propensity score-1yr persistence | Derived | | Baseline group comparison |
| **non2e(x)** | Non-science major propensity score-2yr persistence | Derived | | Baseline group comparison |
| **oth1e(x)** | Other science major propensity score-1yr persistence | Derived | | Baseline group comparison |
| **oth2e(x)** | Other science major propensity score-2yr persistence | Derived | | Baseline group comparison |
| **phy1_e(x)** | Physical science major propensity score-1yr persistence | Derived | | Baseline group comparison |
| **phy2e(x)** | physical science major propensity score-2yr persistence | Derived | | Baseline group comparison |
| **soc1e(x)** | Social science major propensity score-1yr persistence | Derived | | Baseline group comparison |
| **soc2e(x)** | Social science major propensity score-2yr persistence | Derived | | Baseline group comparison |
| **F3QRACE=1** | R/E-Asian/Pacific Islander | F3 | 2 years beyond HS | Demographics |

| | | | | |
|---|---|---|---|---|
| **F4ASIAN** | R/E Asian marker | F4 | PS and beyond | Demographics |
| **F4ED16YR_1** | Degree within 6 years | F4 | PS and beyond | Demographics |
| **F4SEX1** | Male | F4 | PS and beyond | Demographics |
| **HISP_1** | Hispanic Ethnicity | F4 | PS and beyond | Demographics |
| **1yr persistence** | In same major code 1 years after listing initial major | F4 | PS and beyond | Dependent variable |
| **2yr persistence** | In same major code 2 years after listing initial major | F4 | PS and beyond | Dependent variable |
| **F3QRACE=1*MAJLIFE_1** | A/PI life sci. major | Derived | | Interaction |
| **F3QRACE=2*MAJLIFE_1** | Hisp. life science major | Derived | | Interaction |
| **F3QRACE=2*MAJNONSCI_1** | Hisp. Non-science major | Derived | | Interaction |
| **F3QRACE=2*MAJOTHERSCI_1** | Hisp. Other science major | Derived | | Interaction |
| **F3QRACE=2*MAJPHYS_1** | Hisp. Physical science major | Derived | | Interaction |
| **F3QRACE=2*MAJSSCI_1** | Hisp. Social science major | Derived | | Interaction |

APPENDIX B (CONTINUED)

| | | | |
|---|---|---|---|
| **F3QRACE=3*MAJLIFE_1** | Black life science major | Derived | Interaction |
| **F3QRACE=3*MAJNONSCI_1** | Black non-science major | Derived | Interaction |
| **F3QRACE=3*MAJOTHERSCI_1** | Black other science major | Derived | Interaction |
| **F3QRACE=3*MAJPHYS_1** | Black physical science major | Derived | Interaction |
| **F3QRACE=3*MAJSSCI_1** | Black social science major | Derived | Interaction |
| **F3QRACE=4*MAJLIFE_1** | White life science major | Derived | Interaction |
| **F3QRACE=4*MAJNONSCI_1** | White non-science major | Derived | Interaction |
| **F3QRACE=4*MAJOTHERSCI_1** | White other science major | Derived | Interaction |
| **F3QRACE=4*MAJPHYS_1** | White physical science major | Derived | Interaction |
| **F3QRACE=4*MAJSSCI_1** | White social science major | Derived | Interaction |
| **F3QRACE=5*MAJLIFE_1** | NA/AI life science major | Derived | Interaction |
| **F3QRACE=5*MAJNONSCI_1** | NA/AI non-science major | Derived | Interaction |
| **F3QRACE=5*MAJOTHERSCI_1** | NA/AI other science major | Derived | Interaction |

| | | | |
|---|---|---|---|
| **F3QRACE=5*MAJPHYS_1** | NA/AI physical science major | Derived | Interaction |
| **F3QRACE=5*MAJSSCI_1** | NA/AI social science major | Derived | Interaction |
| **F3QRACE=1*F4SEX1** | A/PI male | Derived | Interaction variable |
| **F3QRACE=2*F4SEX1** | Hispanic Male | Derived | Interaction variable |
| **F3QRACE=3*F4SEX1** | Black Male | Derived | Interaction variable |
| **F3QRACE=4*F4SEX1** | White male | Derived | Interaction variable |
| **F3QRACE=5*F4SEX1** | NA/AI male | Derived | Interaction variable |
| **F4SEX1*MAJLIFE_1** | Male life science major | Derived | Interaction variable |
| **MAJNONSCI_1*F3QRACE=1** | A/PI non-science major | Derived | Interaction variable |
| **MAJNONSCI_1*F4SEX1** | male non-science major | Derived | Interaction variable |
| **MAJOTHERSCI_1*F3QRACE=1** | A/PI other science major | Derived | Interaction variable |
| **MAJOTHERSCI_1*F4SEX1** | male other science major | Derived | Interaction variable |
| **MAJPHYS_1*F3QRACE=1** | A/PI physical science major | Derived | Interaction variable |

APPENDIX B (CONTINUED)

| | | | | |
|---|---|---|---|---|
| **MAJPHYS_1*F4SEX1** | male physical science major | Derived | | Interaction variable |
| **MAJSSCI_1*F3QRACE=1** | A/PI social science major | Derived | | Interaction variable |
| **MAJSSCI_1*F4SEX1** | male social science major | Derived | | Interaction variable |
| **EDEXPECT_1** | Ed expectations college or above (b4) | F4 | PS and beyond | Motivation/Aspirations |
| **F3OCC30** | Expected occupation at 30 is science related | F3 | 2 years beyond HS | Motivation/Aspirations |
| **OCCFUTCD_1** | Expected occupation in science | F3 | 2 years beyond HS | Motivation/Aspirations |
| **F4IDRINK** | Alcohol consumption (f4) | F4 | PS and beyond | Negative Social Capital |
| **F4ISMOKE** | How often smoke (f4) | F4 | PS and beyond | Negative Social Capital |
| **ILLDISBL_1** | Family became seriously ill or disabled | F4 | PS and beyond | Negative Social Capital |
| **ARRESTED_1** | respondent or close friend arrested (b4) | F4 | PS and beyond | Negative Social Capital |
| **CRIME_1** | Family or respondent ever been a victim of a crime | F4 | PS and beyond | Negative Social Capital |
| **DEATH_1** | death in family | F4 | PS and beyond | Negative Social Capital |
| **F3EVDOST_1** | Ever dropped out | F3 | 2 years beyond HS | Negative Social Capital |

APPENDIX B (CONTINUED)

| | | | | |
|---|---|---|---|---|
| **BIOLOGY_1** | Had courses in Biology | F4 | PS and beyond | Social Capital |
| **COUNSEL** | Having or received services from formal counseling (personal, academic, financial, or career) B4 | F4 | PS and beyond | Social Capital |
| **F212BCy_1** | Chose HS program after talking to parents | F2 | HS- Senior | Social Capital |
| **F2P44A** | How often PT contacted school about teen's acad. Performance | F2 | HS- Senior | Social Capital |
| **F2P44B** | How often PT contacted school about teen's acad. program | F2 | HS- Senior | Social Capital |
| **F2P44C** | How often PT contacted school about teen's plans after HS | F2 | HS- Senior | Social Capital |
| **F2P44D** | How often PT contacted school about college prep program | F2 | HS- Senior | Social Capital |
| **F2P44E** | How often PT contacted school about teen's attd at HS | F2 | HS- Senior | Social Capital |
| **F2P44F** | How often PT contacted school about child's behavior | F2 | HS- Senior | Social Capital |
| **F2P44G** | how often PT contacted school about volunteering or help fundraise | F2 | HS- Senior | Social Capital |
| **F2P45A_1** | Pt attd program about Post-HS opps. | F2 | HS- Senior | Social Capital |
| **F2P45B_1** | PT attd program for Financial aid | F2 | HS- Senior | Social Capital |

| | | | | |
|---|---|---|---|---|
| **F2P46A_1** | PT knows which courses teen is taking | F2 | HS- Senior | Social Capital |
| **F2P46B_1** | PT knows how well teen is doing in school | F2 | HS- Senior | Social Capital |
| **F2P49A** | How often PT discuss with teen selecting courses | F2 | HS- Senior | Social Capital |
| **F2P49B** | How often PT discuss with teen school activities | F2 | HS- Senior | Social Capital |
| **F2P49C** | How often PT discuss with teen has studies in class | F2 | HS- Senior | Social Capital |
| **F2P49D** | How often PT discuss with teen their grades | F2 | HS- Senior | Social Capital |
| **F2P49F** | How often PT discuss with teen about applying to colleges or other schools after HS | F2 | HS- Senior | Social Capital |
| **F2P49I** | How often PT discuss with teen things that are troubling them | F2 | HS- Senior | Social Capital |
| **F2P49J** | How often PT discuss with teen their special interests or hobbies | F2 | HS- Senior | Social Capital |
| **F2P50A** | How often attd school plays/sports w/ teen | F2 | HS- Senior | Social Capital |
| **F2P50B** | How often work with teen on HW or school projects | F2 | HS- Senior | Social Capital |
| **F2P50C** | How often attd plays/concerts/sports w/ teen outside of school | F2 | HS- Senior | Social Capital |

| | | | | |
|---|---|---|---|---|
| **F2P50D** | How often attended sporting events w/teen outside of school | F2 | HS- Senior | Social Capital |
| **F2P50E** | How often PT attended religious services w child | F2 | HS- Senior | Social Capital |
| **F2P50F** | How often attd family functions w/ teen | F2 | HS- Senior | Social Capital |
| **F2P50G** | How often take day trips or vacation w/ teen | F2 | HS- Senior | Social Capital |
| **F2P50H** | How often attd school plays/sports w/ teen | F2 | HS- Senior | Social Capital |
| **F2P50I** | How often PT went shopping w/teen | F2 | HS- Senior | Social Capital |
| **F2P50J** | How often go out to restaurant w/ teen | F2 | HS- Senior | Social Capital |
| **F2P50K** | How often PT spent time just talking w/teen | F2 | HS- Senior | Social Capital |
| **F2P50L** | How often did something else fun w/ teen | F2 | HS- Senior | Social Capital |
| **F2P54B1_1** | PT knows parents of ST 1st friend | F2 | HS- Senior | Social Capital |
| **F2P54B2_1** | PT knows parents of ST 2nd friend | F2 | HS- Senior | Social Capital |
| **F2P55** | # of pts that pt. talks to at teen's school | F2 | HS- Senior | Social Capital |
| **F2P56A** | How often discuss things @ teen's school w/ other pts. | F2 | HS- Senior | Social Capital |

| | | | | |
|---|---|---|---|---|
| **F2P56B** | How often discuss teen's ed plans w/ other pts @ teen's school | F2 | HS- Senior | Social Capital |
| **F2P56C** | How often discuss teen's career plans w/ other pts @ teen's school | F2 | HS- Senior | Social Capital |
| **F2P59_1** | How involved PT feels in the community | F2 | HS- Senior | Social Capital |
| **F2P60** | How safe is neighborhood | F2 | HS- Senior | Social Capital |
| **F2P62A_1** | Encouraged teen to prepare for SAT | F2 | HS- Senior | Social Capital |
| **F2P62B_1** | Encouraged teen to prepare for ACT | F2 | HS- Senior | Social Capital |
| **F2P63** | How often PT talked to child about applying for college | F2 | HS- Senior | Social Capital |
| **F2S100A** | How often Pt checked teen's HW | F2 | HS- Senior | Social Capital |
| **F2S106** | How often attend religious services | F2 | HS- Senior | Social Capital |
| **F2S26A_1** | Teacher helped with HW | F2 | HS- Senior | Social Capital |
| **F2S26D_1** | Brother/sister helped w/ HW | F2 | HS- Senior | Social Capital |
| **F2S33C** | How often participated in religious activities | F2 | HS- Senior | Social Capital |
| **F2S33G** | How often talking or doing things with your friends | F2 | HS- Senior | Social Capital |
| **F2S33H** | How often talking or doing things with mother/father | F2 | HS- Senior | Social Capital |
| **F2S37_1** | Community volunteer in past 2 years | F2 | HS- Senior | Social Capital |

APPENDIX B (CONTINUED)

| | | | | |
|---|---|---|---|---|
| **F2S40D** | How important to have strong friendships | F2 | HS- Senior | Social Capital |
| **F2S40F** | How important to help community | F2 | HS- Senior | Social Capital |
| **F2S41F_1** | Favorite teacher thinks its important for Teen to go to college after HS | F2 | HS- Senior | Social Capital |
| **F2S67J** | Changes in the future you will have friends you can count on | F2 | HS- Senior | Social Capital |
| **F2S68A** | Among close friends, how important to attend class regularly? | F2 | HS- Senior | Social Capital |
| **F2S68B** | Among close friends, how important to study? | F2 | HS- Senior | Social Capital |
| **F2S68D** | Among close friends, how important to get good grades | F2 | HS- Senior | Social Capital |
| **F2S68H** | Among close friends, how important to continue ed past HS | F2 | HS- Senior | Social Capital |
| **F2S68I** | Among close friends, how important to participate in relg. activities | F2 | HS- Senior | Social Capital |
| **F2S68J** | Among close friends, how important to do community work/volunteer | F2 | HS- Senior | Social Capital |
| **F2S97** | PTs know closest friend's pts. | F2 | HS- Senior | Social Capital |

APPENDIX B (CONTINUED)

| | | | | |
|---|---|---|---|---|
| **F2S99B** | How often discussed school courses w/PT | F2 | HS- Senior | Social Capital |
| **F2S99I** | How often discussed things troubling you with PT | F2 | HS- Senior | Social Capital |
| **F2SP43B** | How often school contacted PT about students acad. Program | F2 | HS- Senior | Social Capital |
| **F3RGVOTE_1** | Registered to Vote | F3 | 2 years beyond HS | Social Capital |
| **F3STILL_1** | Still enrolled at 1st PSE | F3 | 2 years beyond HS | Social Capital |
| **F3VOTED_1** | Voted in past election | F3 | 2 years beyond HS | Social Capital |
| **F4BHBJ** | Used networking to get current job | F3 | 2 years beyond HS | Social Capital |
| **F4ICIVIC_1** | Volunteered at civic or community center in past yr. | F4 | PS and beyond | Social Capital |
| **F4ICULT** | How often of to plays, concerts, museums (F4) | F4 | PS and beyond | Social Capital |
| **F4ILIBRY** | How often go to public library (f4)] | F4 | PS and beyond | Social Capital |
| **F4IRELIG** | How often participated in organized religion (f4) | F4 | PS and beyond | Social Capital |
| **F4ISPORT** | How often participated in organized sports | F4 | PS and beyond | Social Capital |
| **F4IYOUTH_1** | Volunteered at youth organization in past yr. | F4 | PS and beyond | Social Capital |

APPENDIX B (CONTINUED)

| | | | | |
|---|---|---|---|---|
| **INTRATH_1** | participated in intramural athletics (b4) | F4 | PS and beyond | Social Capital |
| **NUMINST_A** | Number of institutions attended | F4 | PS and beyond | Social Capital |
| **PARSPORT_1** | Outside of school did sports at least 1x week | F4 | PS and beyond | Social Capital |
| **PERFARTS_1** | Outside of school did performing arts 1x week | F4 | PS and beyond | Social Capital |
| **PHYSICS_1** | Had courses in physics | F4 | PS and beyond | Social Capital |
| **PSEFIRST** | enrollment status at 1st PSE (part, half, full time) | F4 | PS and beyond | Social Capital |
| **SOCLCLUB_1** | Participated in social clubs or frats | F4 | PS and beyond | Social Capital |
| **SPECINST** | Having or received specific instruction in math/reading | F4 | PS and beyond | Social Capital |
| **STDTGOV_1** | Participated in Intercollegiate Varsity sports (b4) | F4 | PS and beyond | Social Capital |
| **TALKPARN_1** | Spent time talking or doing things with parents | F4 | PS and beyond | Social Capital |
| **TUTOR** | Having or received services from formal tutoring by faculty or students B4 | F4 | PS and beyond | Social Capital |
| **VARATH_1** | Intercollegiate Varsity sports (b4) | F4 | PS and beyond | Social Capital |

APPENDIX B (CONTINUED)

| | | | | |
|---|---|---|---|---|
| **VOLUCMTY_1** | Volunteer servicing the community | F4 | PS and beyond | Social Capital |
| **VOLUSTDT_1** | Volunteer servicing other students | F4 | PS and beyond | Social Capital |
| **CHEMSTRY_1** | Had courses in chemistry | F4 | PS and beyond | Social capital in science |
| **F3QRACE=2** | R/E-Hispanic | F3 | 2 years beyond HS | Demographics |
| **F3QRACE=3** | R/E- Black | F3 | 2 years beyond HS | Demographics |
| **F3QRACE=4** | R/E White | F3 | 2 years beyond HS | Demographics |
| **F3QRACE=5** | R/E Native American/American Indian | F3 | 2 years beyond HS | Demographics |
| **MAJLIFE_1** | life major indicator | Derived | | Major |
| **MAJNONSCI_1** | Non-science major | Derived | | Major |
| **MAJOTHERSCI_1** | other science major | Derived | | Major |
| **MAJPHYS_1** | physical science major | Derived | | Major |
| **MAJSSCI_1** | social science major | Derived | | Major |

APPENDIX C

**Appendix C. Interview items from Stanton-Salazar (2001)** survey used to design survey

1. What generation immigrant are you? 1st, 2nd, 3rd or beyond
    a. If you are 2nd generation immigrant or later, would you say you feel you identify more with the US, or with your parents/grandparents home country?
2. What is your language of preference? English, bilingual/trilingual, primarily other language (Spanish, French, chinese, german, etc)
3. What is your parents' occupation? List
4. What is the highest level of education your mother completed? Graduate or professional degree, 4 yr degree, 2yr degree or certificate, some college, high school, diploma, some high school, some grade school
5. How many individuals are in your immediate family ? number
6. What is your (college) GPA?
7. Would you consider yourself: working class, middle class, upper class
8. What is the approximate combined income of your parent(s)?

From table c-3

1. My teachers give me the moral support I need to do well in school.
2. Most other students at this school are closer to their teachers than I am.
3. I rely on my teachers for advice and guidance in making important school-related decisions.
4. I rely on our school counselors for advice in making important school-related decisions.
5. My teachers are sensitive to my personal needs.
6. My teachers are good at helping me solve school-related or academic problems.
7. My teachers are good in helping me solve personal problems.
8. My school counselors are good at helping me solve school-related or academic problems.
9. My school counselors are good at helping me solve personal problems.
10. I have a friendly and trusting relationship with a number of teachers.
11. I have a friendly and trusting relationship with at least one of the school counselors.

From other chapters
P 43
Perceptions of neighborhood ecology→ replace with campus climate survey

1. A lot of crime and vandalism in my neighborhood (likert)
2. My house was broken into
3. A lot of drug-pushing and drug use in my neighborhood
4. There was a drive-by shooting in my neighborhood
5. Harassed (treated unfairly) by police

Primary and extended kin

1. At least one adult kin in community/local area (non-parent)
2. Mean number of kin in community/local area
3. At least one adult kin in (county area)
4. Mean number of kin in county area
5. At least one cousin in community/local area
6. Mean number of cousins in community/local area

8. At least one aunt in the community/local area

Parent involvement- as reported by student

1. how many times has one or both of your parents visited our school, for whichever reason (not once, once, twice, 3 to 5 times, 6 or more)
2. my mother (father/guardian) keeps close track of how well I am doing in school (true, false, dna)

APPENDIX D

**Appendix D. UNIV-Survey items.**

Q1 What is your primary major? (If more than one, write all majors, or if undecided write your prospective major or undecided)

Q8 What is your academic status?
- Freshman (1)
- Sophomore (2)
- Junior (3)
- Senior (4)

Q10 Is this the first post-secondary institution you have attended?
- Yes (1)
- No (2)

Answer If Is this the first post-secondary institution you have attended? No Is Selected
Q11 What type of institution did you previously attend? (Check all that apply)
- 2-year or community college (1)
- 4-year college or university (2)
- Technical school/ vocational school (3)
- Other (4) ____________________

Q9 How many years have you been at this institution?
- 1 year (1)
- 2-4 years (2)
- 5 or more years (3)

Answer If How would you describe your major? science major Is Selected
Q4 How would you describe your major? As a...
- Life or biological science (1)
- Physical science (2)
- Engineering, or computer science (3)
- Mathematics science (4)
- Other science (5)

Q5 How do you self-identify your gender?
- Male (1)
- Female (2)
- Other (3) ____________________
- Gender non-conforming (4)

Q6 How would you self-identify your race/ethnicity?
- White, non-Hispanic (1)
- Black, non-Hispanic or African-American (2)

Asian, Pacific Islander, Native Alaskan (3)
Native American, First Nations, American Indian (4)
Hispanic, Latino/a, Chicano/a (5)
Bi-racial, or more than one race (6)
Other (7) ____________________

Q13 What is your GPA?

Q47 When you chose UIC over other decisions, how important were the following in this decision? (Not at all Important (1) to Extremely Important (5)
Campus academic programs (such as GPPA, Honors College, TRIO, undergraduate research opportunities, etc.) (1)
Campus diversity (2)
Campus proximity to an urban center (3)
Scholarships/low-tuition costs (4)
Recommendation from teachers/counselor (5)
Recommendation from family/friends (6)
Close to home (7)
Other (8)

Q15 Would you consider you and your family...
Working class (1)
Middle class (2)
Upper class (3)

Q29 What is the highest education that any of your parents achieved?
Less than HS (1)
High school or equivalent (2)
Trade school/vocational school/ college certification (3)
2 yr college degree (4)
4yr college degree (5)
Professional degree/graduate degree (6)

Q30 Did you attend HS in this country?
Yes (1)
No (2)

Q31 Are your parents and immediate family within easy contact?
Yes (1)
No (2)

Q31 Do you consider your family as immigrants to the US, or natives to the US?
Immigrants (1)
Natives (2)

APPENDIX D (CONTINUED)

*Answer If Do you consider your family as immigrants to the US, or natives to the US? Immigrants Is Selected*

Q32 What generation of immigrant do you consider yourself to be?

- 1st generation (you immigrated here) (1)
- 1.5 generation (you immigrated here at a young age and grew up in the US) (2)
- 2nd generation (your parents immigrated here) (3)
- 3rd+ generation (your grandparents or older generation immigrated here) (4)

Q33 Do you speak a foreign language fluently?

- Yes (1)
- No (2)

Answer If Do you speak a foreign language fluently? Yes Is Selected

Q34 Which language do you prefer

- English (1)
- Another language (2)
- bilingual/trilingual/doesn't matter (3)

Q39 When you were growing up, did you have a family member or family friend who was a scientist?

- Yes (1)
- No (2)

Answer If When you were growing up, did you have a family member or family friend who was a scientist? Yes Is Selected

Q48 How many family members/family friends did you have that were scientists?

- 1 (1)
- 2-3 (2)
- More than 3 (3)

Q14 How many family members are in your immediate family?

- Less than 3 (1)
- 3-5 (2)
- more than 5 (3)

Q12 When do you reach out to your family for support?

- Never (1) -Often (4)

Do you discuss academic problems with your family? (1)

Do you discuss your troubles or emotional issues with your family? (2)

Do you discuss financial problems with your family? (3)

Do you discuss moral issues with your family? (4)

Do you discuss religious issues with your family? (5)

Q25 When do you reach out to your friends for support?

Never (1)-Often (4)
Do you discuss academic problems with your friends? (1)
Do you discuss your troubles or emotional issues with your friends? (2)
Do you discuss financial problems with your friends? (3)
Do you discuss moral issues with your friends? (4)
Do you discuss religious issues with your friends? (5)

Q16 When it comes to campus staff, how supported do you feel?
Strongly Disagree - Strongly Agree
My professors are supportive (1)
My academic and/or peer counselors are supportive (2)
My teaching assistants (TA) are supportive (3)
Online FAQs or other non-human resources are supportive (4)

Q17 When it comes academic problems in general, who do you look to for support?
Never (1)- All of the Time (5)
Parents or other family members (1)
Friends on campus or in school (2)
Other friends not at UIC (3)
Campus or peer counselors (formal) (4)

Q22 When it comes to academic problems in science or STEM classes, who do you look to for support?
Never (1)- All of the Time (5)
Parents or other family members (1)
Friends on campus or in school (2)
Other friends (3)
Campus or peer counselors (formal) (4)

Q30 Think back to your high school or secondary school experience. How much do you agree with the following statements?
Strongly Disagree (1) -Strongly Agree (5)
My high school science teachers were more supportive than my professors (1)
My high school counselors were more supportive than my university counselors (2)
My high school friends were more supportive than my college friends (3)
My family was more supportive of my high school education than my college education. (4)

Q31 How likely are you to ask the following people for help in financial situations
Very Unlikely (1)-Very Likely (7)
Family (1)
University friends (2)
HS or family friends (3)
Banks or other institutions (4)

UIC or other financial services (5)

Q32 How likely are you to ask the following people for help with social or emotional issues
Very Unlikely (1)-Very Likely (7)
Family (1)
University Friends (2)
HS or family friends (3)
UIC or other health services (4)
Online or phone call-in (5)

Q29 How well do you know the following...
None (1)-Very well (5)
Your Professors (1)
Your classmates in science class (2)
Your Teaching Assistants (TAs) (3)
Academic counselors (4)
Non-academic counselors (clinic, etc) (5)

Q34 When it comes to your academics do your...
Strongly Disagree -Strongly Agree
Family friends think it's very important (1)
Family members think it's very important (2)
Campus friends think it's very important (3
Campus staff (professors, TAs, counselors) (4)

Q20 What majors do your close friends at UIC study?
My major (1)
Another science or STEM major (2)
non-STEM or non-science major (3)
My close friends are not at UIC (4)

Q26 In general, most people
Strongly Disagree (1) -Strongly Agree (5)
Can be trusted (1)
you can't be too careful dealing with people (2)
will try to take advantage to your if they have a chance (3)
try to be fair (4)
try to be helpful (5)
are just looking out for themselves (6)

Q35 How much do you agree with the following when it comes to support you receive from your professors at UIC?

Strongly Disagree (1) -Strongly Agree (5)
Professors provide me with the support I need to succeed (1)
Most other students are closer to their professors than I (2)
I depend on professors or other school staff for academic decisions (3)
My professors are sensitive to my personal needs (4)
I have a friendly and trusting relationship with my professors (5)
I have a friendly or supportive relationship with at least one professor (6)

Q37 How do you feel about the support you receive
Strongly Disagree (1) - Strongly Agree (5)
School counselors provide me with the support I need to succeed (1)
Most other students are closer to their school counselors than I (2)
I depend on School counselors or other school staff for academic decisions (3)
My School counselors are sensitive to my personal needs (4)
I have a friendly and trusting relationship with my School counselors (5)
I have a friendly or supportive relationship with at least one School counselors (6)

Q36 At UIC, how often do you feel...
Never (1)- Very often (5)
Insulted or threatened because of your race/ethnicity (1)
had tense, or somewhat hostile race-related interactions (2)
had guarded/cautious race-related interactions (3)
been singled out because of race/ethnicity, gender or sexual orientation (4)
heard faculty express stereotypes about racial/ethnic groups in class (5)

Q37 For you to feel like a real scientist, how important is...
Not at all Important (1)- Extremely Important (5)
obtaining recognition from your colleagues for contributions in your field (1)
becoming an authority in your field of science (2)
making a theoretical contribution to science (3)
working to find a cure to a health problem (4)

Q40 On campus, in general I feel like
Strongly Disagree (1) Strongly Agree (5)
I belong here on campus (1)
all students are respected regardless of their race/ethnicity (2
all students are respected regardless of their religion (3)
all students are respected regardless of their gender (4)
all students are respected regardless of their sexual orientation (5)
all students are respected regardless of their social class (6)

Q41 When it comes to your academic work how often do you...
Never (1)- Daily (7)
Study with fellow students (1)

work in an undergraduate research opportunity (2)
tutored other students (3)
visited the library (4)
participated in academic club/organization activities (5)

Q43 How many people helped you make the following decisions as you transitioned from high school to college?

None (1)- A Lot (4)

Selection of you major (1)
Selection of UIC over other universities (2)
Selection to go to a 4-year university (3)
Application to scholarships (4)
completing FAFSA or other financial aid (5)
completing a college application (6)

Q45 How many people helped could you have asked for help in making the following decisions as you transitioned from high school to college?

None (1)- A Lot (4)

Selection of you major (1)
Selection of UIC over other universities (2)
Selection to go to a 4-year university (3)
Application to scholarships (4)
completing FAFSA or other financial aid (5)
completing a college application (6)

Q52 Thank you for your participation! In order to understand more about the experiences underrepresented students in STEM majors, this study is seeking participants from underrepresented groups in STEM, and specifically Latin@ students in STEM majors for an interview lasting 1 to 2 hours. If you would like to participate, and self-identity as an underrepresented students in STEM, please enter a contact email, or phone number below. Students who participate in the interviews will be entered into a raffle to win an iPad:

APPENDIX E

**Appendix E. Variable List UNIV survey items.**

| Variable name | Description | |
|---|---|---|
| **0FAMSCI** | 0 family members are scientists | Recode of item into dummy variable |
| **0GEN** | nonimmigrant status | Recode of item on number into dummy variables |
| **1.5GEN** | 1.5 generation immigrant | Recode of item on number into dummy variables |
| **1FAMSCI** | 1 family members is scientists | Recode of item on number into dummy variables |
| **1GEN** | 1st generation immigrant | Recode of item on number into dummy variables |
| **1INT2YR** | 1st PSE was a 2yr institution | Recode of item on number into dummy variables |
| **1INT4YR** | 1st PSE was a 4yr institution | Recode of item on number into dummy variables |
| **1INTUIC** | 1st PSE was at UNIV. | Recode of item on number into dummy variables |
| **2FAMSCI** | 2 family members are scientists | Recode of item on number into dummy variables |
| **2GEN** | 2nd gen. immigrant | Recode of item on number into dummy variables |
| **3FAMSC** | 3 family members are scientists | Recode of item on number into dummy variables |
| **3GEN** | 3rd generation immigrant | Recode of item on number into dummy variables |
| **ACADYR=1** | Academic year-Freshman | |
| **ACADYR=2** | Academic year-Sophomore | |
| **ACADYR=3** | Academic year-Junior | |
| **ACADYR=4** | Academic year-Senior | |
| **ACADYR** | academic year | Recode of item on number into dummy variables |
| **FAMEZCT** | Family in easy contact | |
| **FAMSIZE** | Family size | |
| **FRINUNIV** | Close friends not at UNIV | Recode of item on number into dummy variables |
| **FRMYMJ** | Close friends are in my major | Recode of item on number into dummy variables |
| **FRNSMJ** | Close friends in non-science major | Recode of item on number into dummy variables |
| **FROTHMJ** | Close friends in other science major | Recode of item on number into dummy variables |
| **IMIGNT** | Immigrant Code | |

| | | |
|---|---|---|
| **MAJLIFEB** | Life science major | Recode of item on number into dummy variables- Used NSF definitions |
| **MAJOTHB** | Other science major | Recode of item on number into dummy variables- Used NSF definitions |
| **MAJPHYSB** | physical science major | Recode of item on number into dummy variables- Used NSF definitions |
| **PARED2** | Parents highest ed is 2yr college | Recode of item on number into dummy variables |
| **PARED4** | Parents highest ed is 4yr college | Recode of item on number into dummy variables |
| **PAREDCO** | Parents highest ed is some college | Recode of item on number into dummy variables |
| **PAREDHS** | Parents highest ed is hs | Recode of item on number into dummy variables |
| **PAREDNH** | Parents highest ed is less than HS degree | Recode of item on number into dummy variables |
| **PAREDP** | Parents ed is professional degree or doctorate | Recode of item on number into dummy variables |
| **PAREDT** | Parents highest ed is VoTec degree | Recode of item on number into dummy variables |
| **PRFBTH** | Language preference- foreign and English | Recode of item on number into dummy variables |
| **PRFENG** | Language preference- English | Recode of item on number into dummy variables |
| **PRFFRG** | Language preference- foreign | Recode of item on number into dummy variables |
| **RACEETHMID** | Race/eth self-identified as Middle Eastern | Recode of item on number into dummy variables |
| **RACETH2** | Race/eth self-identified as biracial or 2 or more races | Recode of item on number into dummy variables |
| **RACETHA** | Race/eth self-identified as Asian/Pacific Islander | Recode of item on number into dummy variables |
| **RACETHB** | Race/eth self-identified as African-American or Black | Recode of item on number into dummy variables |

| | | |
|---|---|---|
| **RACETHO** | Race/eth self-identified as Other | Recode of item on number into dummy variables |
| **RACETHW** | Race/eth self-identified as Caucasian or White | Recode of item on number into dummy variables |
| **SPKFRGN** | Speak foreign language | |
| **WMJSCAB** | Weights- match population proportions of Life, Physical, and Other science majors | |
| **ZFAMACD** | Sum value of Family academic social capital | **α**= .704 |
| **ZFQCLUB** | frequency attending campus clubs | Recode of item on number into dummy variables |
| **ZFQLIB** | frequency attending the library | Recode of item on number into dummy variables |
| **ZFQSTUDS** | Frequency studying | Recode of item on number into dummy variables |
| **ZFQTUTR** | frequency seeking tutoring | Recode of item on number into dummy variables |
| **ZFQUGRSH** | Frequency doing undergrad. Research | Recode of item on number into dummy variables |
| **ZFRIACD** | Sum Value of friend academic social capital | **α**= .723 |
| **zGPA** | z-score: GPA | |
| **ZPRFacd** | Sum value of faculty social capital | **α**= .723 |
| **ZRACAPRO** | Came to UNIV because of academic programs | Recode of item on number into dummy variables |
| **ZRACSUM** | Sum term for Racial campus climate | **α**= .906 |
| **ZRCLSHOM** | Came to UNIV bc of low cost | Recode of item on number into dummy variables |
| **ZRCOST** | Came to UNIV bc close to home | Recode of item on number into dummy variables |
| **ZRRECFAM** | Came to UNIV bc family recruited | Recode of item on number into dummy variables |
| **ZSCIIDSUM** | Sum of science id measures | **α**= .720 |
| **ZSES_WMU** | Z-Score: Self-identified SES | |

**Appendix F. General interview summary**

1. What are your goals for your education? Why are you studying science?

2. Where do these goals come from? (does family play a role? Encouraged early? HS-> college friends?) One of the things you indicated on the survey was that is it important for you to feel like an expert in the field? What about what you want to do needs this expertise? Why BIO and not another SCIENCE?

3. What was your science journey like? Your past history in HS, and before? Were you always attracted to science? Who made science attractive to you?

4. What does it mean to be a Latin@ here on campus? Do you feel this matters for what you study and how you are treated on campus? Have you ever seen instances where Latin@s are treated differently in classes or on campus? This is an HSI, did this matter to you?

5. (ask more specific- ie NOT generalized- talk about the last time you had trouble in science, or a typical day, this semester, or last semester…) I was wondering if you could tell me more about what it means to be a bio major here at UIC. Can you walk me through your busiest days? What do you do, and where do you go? How would you describe it to your parents or friends who aren't science majors?

6. What makes being a bio student from being a science student in other majors? Do the things and spaces you interact with change depending on the type of science you study? Is this different than say a chem major? Did you see a difference in biology, chemistry and physics? Were there different pressures and supports in these places?

7. Have there been negative experiences here at UIC? Can you tell about the last negative experience you had? Do you think this would have happened in an other major? Another science major?

8. Having said all that, would you tell a younger sibling or cousin that this the SCEINCE spaces were welcoming of you? Do you think that who you are matters for this welcoming? How hard do you think it is to make it through a bio major here? If someone asked you, what would you point out ?

9. So, why did you decide to stay in science? Or in bio? Was this your initial major? Why stay at UIC? How did you come to make these choices in the first place?

10. Where have you found support, either at UIC, or outside of school? I know you mentioned that you receive a bit of support from your friends. Have you had common experiences here? Like the example you mentioned earlier?
    a. **Who were those that really supported you?**
    b. How did they really support you?

11. What characterizes the support you receive? Like are we talking research opportunities, help with HW…? Was this in specifically in biology, or was this also something you saw in other science majors.

12. In your survey you talked about not feeling too close with professors compared to your classmates? Is there any examples you can think of that made you feel this way?

13. Why do you feel particularly close to your counselor compared to other students? Is this a science counselor, or like a LARES counselor? How did you connect?

14. Is there something that you think concerning helping students stay in science majors, that we totally missed talking about?

APPENDIX G

**Appendix G. IRB Approval**

UNIVERSITY OF ILLINOIS
AT CHICAGO

Office for the Protection of Research Subjects (OPRS)
Office of the Vice Chancellor for Research (MC 672)
203 Administrative Office Building
1737 West Polk Street
Chicago, Illinois 60612-7227

**Approval Notice**
**Initial Review (Response to Modifications)**

April 14, 2016

David Segura, M.Ed
Policy Studies
1040 W. Harrison St.
M/C 147
Chicago, IL 60612

RE: **Protocol # 2016-0073**
**"Examining Social Capital of Latin@s to Persist in STEM Majors"**

Dear Mr. Segura:

Your Initial Review application (Response to Modifications) was reviewed and approved by the Expedited review process on April 5, 2016. You may now begin your research

Please note the following information about your approved research protocol:

**Please note that stamped and approved .pdfs of all recruitment and consent documents will be forwarded as an attachment to a separate email. OPRS/IRB no longer issues paper letters and stamped/approved documents, so it will be necessary to retain these emailed documents for your files for auditing purposes.**

**Protocol Approval Period:** April 5, 2016 - April 5, 2017
**Approved Subject Enrollment #:** 500
**Additional Determinations for Research Involving Minors:** These determinations have not been made for this study since it has not been approved for enrollment of minors.
**Performance Site:** UIC
**Sponsor:** None

**Research Protocol:**

a) Examining the Social Capital of Latin@s to Persist in STEM Majors; Version 1; 01/19/2016

**Recruitment Material:**

a) Recruitment Document; Version 2; 03/26/2016

**Informed Consents:**

a) Consent Document; Version 2; 03/26/2016
b) A waiver of documentation (electronic consent/no written signature obtained) for the online survey only under 45 CFR 46.117(c)(2) (minimal risk; subjects will be presented with online information sheet containing all of the elements of consent)
c) Social Capital Qualtrics Survey, Q 50, 2, 49, 53 at beginning; Q 52, 54 at end

Your research meets the criteria for expedited review as defined in 45 CFR 46.110(b)(1) under the following specific categories:

(6) Collection of data from voice, video, digital, or image recordings made for research purposes., (7) Research on individual or group characteristics or behavior (including but not limited to research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

**Please note the Review History of this submission:**

| Receipt Date | Submission Type | Review Process | Review Date | Review Action |
|---|---|---|---|---|
| 01/22/2016 | Initial Review | Expedited | 02/17/2016 | Modifications Required |
| 02/24/2016 | Response To Modifications | Expedited | 03/10/2016 | Modifications Required |
| 03/28/2016 | Response To Modifications | Expedited | 04/05/2016 | Approved |

Please remember to:

→ Use your **research protocol number** (2016-0073) on any documents or correspondence with the IRB concerning your research protocol.

→ Review and comply with all requirements on the OPRS website under:
"UIC Investigator Responsibilities, Protection of Human Research Subjects"
(http://tigger.uic.edu/depts/ovcr/research/protocolreview/irb/policies/0924.pdf)

**Please note that the UIC IRB has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.**

**Please be aware that if the scope of work in the grant/project changes, the protocol must be amended and approved by the UIC IRB before the initiation of the change.**

We wish you the best as you conduct your research. If you have any questions or need further help, please contact OPRS at (312) 996-1711 or me at (312) 996-2014. Please send any correspondence about this protocol to OPRS at 203 AOB, M/C 672.

Sincerely,
Sandra Costello
Assistant Director, IRB # 2
Office for the Protection of Research Subjects

**Please note that stamped and approved .pdfs of all recruitment and consent documents will be forwarded as an attachment to a separate email. OPRS/IRB no longer issues paper letters and stamped/approved documents, so it will be necessary to retain these emailed documents for your files for auditing purposes.**

cc: Benjamin M. Superfine, Policy Studies, M/C 147
Shelby Cosner (faculty advisor), Educational Policy Studies, M/C 147

APPENDIX H

**Appendix H. Curriculum Vitae**

David Segura
Doctoral Candidate
Department of Educational Policy Studies
1040 W Harrison St
Chicago, IL 60607
Email: dsegur2@uic.edu

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***EDUCATION***

PhD Educational Policy Studies, University of Illinois at Chicago, Summer 2018 (anticipated)
MEd Measurement, Evaluation, Statistics and Assessment in Education, University of Illinois at Chicago, 2013.
MEd Curriculum & Instruction-Secondary Education, University of Illinois at Chicago, 2007.
BS/BA Biology/Chemistry, University of Illinois at Chicago, 2005.

***RESEARCH ASSISTANSHIPS***

Research Assistant for Science Education for Excellence and Equity in Chicago (Project SEEEC): PI: Maria Varelas, Ph.D., NSF Award Number #1439761. Research assistantship included collecting, transcribing, coding, and analyzing data, as well as presenting findings at research groups meetings and conferences. 2015-

Research Assistant to the Center for Mathematics Education of Latinos/as (CEMELA): PI: Lena L. Khisty, Ph.D. External Evaluator: M. Jean Young. NSF Grant number: ESI-0424983. Research assistantship included collecting, transcribing, coding, and analyzing data, as well as presenting findings at research groups meetings. 2005-2007.

***TEACHING ASSISTANSHIPS***

Teaching assistant/Instructor of record- Curriculum & Instruction 531- Curriculum, Instruction, and Assessment for Equity in Secondary Science Education. Fall 2017

***OTHER TEACHING EXPERIENCE***

Secondary science teacher (Environmental Science, Chemistry, Biology) and department chair, Social Justice HS, Chicago Public Schools, District 299. 2007-2015

***CONFERENCE PRESENTATIONS AND POSTERS***

2018- ***AERA***-Preservice science teachers and social justice lessons: Negotiating barriers and resources (Paper session)

2018- ***NARST***- Developing identities and changing roles of Latinx science students in college (Paper session)

2018- ***NARST***- Constructing identities as science teachers seeking equity and excellence (Paper session)

2017- ***ASHE***-Modifying or affirming pathways through science: Science identity and social agency (Poster Session)

2017- ***NARST***- Structure and agency in the development of critical consciousness in preservice science teachers (Paper session)

2016- ***NARST***- An auto-ethnographic examination of minority scientist perspectives on science education research (Paper session)

2016- ***NARST***- Community organizations' programming and the development of community science teachers (Paper session)

2015- ***NARST***- Learning science for social justice: Voices from the field (invited panel)

***PUBLICATIONS AND WORK IN PROGRESS***

**Segura, D.**, Varelas, M., Morales-Doyle, D., Batres, B., Cantor. P., Bonilla, D., Frausto, A., Salinas, C., & Thomas, L. (Expected Fall 2019). Negotiating structures and agency in learning to teach science for equity and social justice. In Leonard, J., Burrows, A., & Kitchen, R. (Eds.). *Recruiting, preparing, and retaining STEM teachers for a global generation*. [*Under-review*]

**Segura, D**., & Mohorn-Mintah, O. (forthcoming-expected Fall 2018). Our undergraduate science experiences: The Push to science teaching from science. In Bazzul, J. & Burke, C.A. (Eds.) *Critical Voices in Science Education Research: Narratives of Academic Journeys.*

Morales-Doyle, D., Varelas, M., **Segura, D**., Bernal-Munera, M., & Mitchener, C. (2018). Pre-service secondary science teachers developing sociopolitical understandings: The Work-of-teaching and the structure-agency dialectic. *Journal of Teacher Education. [Under revision]*

Varelas, M., Morales-Doyle, D., Raza, S., **Segura, D**., Canales Salas, K., & Mitchener, C. (2017). Community organizations' programming and the development of community science teachers. *Science Education, 102(1),* 60-84. DOI: 10.1002/sce.21321.

*Work In Progress*

*Segura, D. Negotiating science identity and dis/ability: Articulating decisions to use or refuse accommodations among undergraduate science majors. Anticipated submission to CSSE. Goal: Spring, 2019.*

*Segura, D. Use of institutional supports by Latinx physical and life science majors draw upon to persist or alter science pathways. Goal: Summer, 2019.*

***RELEVANT PROFESSIONAL AFFILIATIONS/MEMBERSHIPS***

2009-Current AERA-Graduate Student Member
2014-Current ASHE- Graduate Student Member
2015-Current NARST-Graduate Student Member