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Understanding Latina adolescents' science identities: A mixed methods study of socialization practices across contexts

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Understanding Latina adolescents' science identities: A mixed methods study of socialization practices across contexts

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Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

May 2014

Dedication

For Mom and Dad: Through your words and your actions, I learned to value education. I hope that what I have done and what I do in the future makes you proud.

For David: You know more than anyone all the work and sacrifice that went into this paper. I thank you always and forever for supporting me.

For Dean and Mitchell: You may have delayed the date on this paper, but it was worth the extra years to have you both in my life.

Acknowledgements

My work would not be possible with the great deal of support I have received from all my professors, but especially Dr. Marie-Anne Suizzo, my mentor. She has been a source of unfailing encouragement. My world is a richer place because of what I have learned from her. I would also like to give special thanks to Dr. Germine Awad for her advice and laughter and to Dr. Toni Falbo for her support of my independent studies. Lastly, I would like to acknowledge all my professors at UT who brought dedication to their work and encouraged me into new ways of thinking.

I also owe great thanks to the participants of this study. Thank you to all the middle school students who took the time to fill out surveys and to the many teachers who helped with the distribution of surveys. I value each individual contribution. I would like to extend a special thanks to Cathy Malerba at Round Rock ISD for her helpful advice. Thanks also to Principals Galloway, Watson, and Hayes and to Ms. Miles for coordinating the distribution of an often overwhelming number of manila envelopes.

Finally, I would like to thank the accomplished young women I was privileged to talk with in focus groups and interviews. You generously lent me your time and told me your stories. I appreciate you and hope that I can use your words to effect change.

Understanding Latina adolescents' science identities: A mixed methods study of socialization practices across contexts

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The University of Texas at Austin, 2014

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Research on differences in STEM outcomes for females and students of color has been an ongoing educational research imperative, but Latinas continue to be under-represented in high school and college science classes and majors (National Science Foundation, 2011; Riegle-Crumb & King, 2010). The aim of this study was to investigate how Latina adolescents seek to establish themselves as future scientists within their environments and how others help sustain these developing identities. I used a mixed method procedure called an exploratory sequential design that starts with a qualitative stage followed by a quantitative stage (Creswell & Plano Clark, 2007).

In the qualitative stage, 32 college-aged Latinas in science majors participated in focus groups with an additional 12 in interviews. Using Interactive Qualitative Analysis (Northcutt & McCoy, 2004), eight factors of science identity development were identified: *home environment, teacher influences, school experiences, environmental factors, media influences, using your brain, emotions,* and *career planning.* Participants saw the first four factors as drivers of their development, with *media* as an irregular contributor. These social factors were filtered through the individual factors of u*sing your brain* and *emotions*, with *career planning* as the outcome.

The qualitative results were used to develop a survey given to middle school students in the next stage. The majority of the survey consisted of previously validated scales that corresponded in content to the qualitative factors. One new measure was developed to address science-related experiences. In the quantitative stage, 90 middle school Latinas from two central Texas school districts participated in the survey study. Univariate analysis showed differences in science-related experiences by demographic variables of parent occupation, parent nativity, first language spoken, and school district. Multivariate regression analysis found positive emotions about science to be the best predictor of science career related outcomes, and that emotions act as a mediator between science experiences and career outcomes. These results are discussed in light of current career theories.

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Chapter 1: Introduction

Statement of Problem

The US Latino population is over 50.5 million and comprises the fastest growing segment of the population (US Census Bureau, 2011). In addition, the Latino community is young, with almost 35% under the age of 18 compared with approximately 23% for the entire US (US Census Bureau, 2011). At the same time that the Latino population is on the rise, the need for individuals in science, technology, engineering, and math (STEM) fields is also increasing. Despite the recent economic recession, data indicates that STEM professions will continue to grow at rates at least double the general workforce average (National Science Board, 2012). Economically, the growing Latino population represents a large, potential labor pool for STEM industries in the United States.

Unfortunately, the growth in the Latino population and the growth in STEM jobs are not aligning. While Latinos constitute approximately 14% of the labor force, they represent only 4% of workers in nonacademic science and engineering occupations (US Census Bureau, 2011; National Science Board, 2012). These fields have a particular problem in recruiting Latina workers. For example, from 2001 to 2010, the number of Latinas receiving a bachelor's degree in a physical science increased from 414 to 563; however both these numbers represent less than 1% of all graduating Latinas (National Science Foundation, 2011). In 2010, only 620 Latinas across the entire US earned a doctorate in a science or engineering field (National Science Foundation, 2011). Altogether, less than 1.5% of native-born Latinas are employed in science and engineering related fields (Gonzales, 2008). With so few Latinas choosing to enter science, the question remains, “Why?”

The problem of too few women entering STEM careers has been described as a “pipeline” problem (National Science Foundation, 2007)—too few going to college, too few entering STEM majors, too few enrolling in graduate school, and too few becoming leaders in their professions. Blickenstaff (2005) likened the loss of women in STEM to a sex-based filter within the pipeline that differently removed men and women. The problem is particularly acute for the physical sciences, computer science, and engineering with Latinas significantly less likely to enter those majors (Riegle-Crumb & King, 2010).

Purpose of study and research questions

Making a choice to enter a science career is often the outward manifestation of an inward process of identity development. The development of an identity as a scientist is hypothesized to have roots in childhood development and socialization experiences (Brickhouse, Lowery, & Schultz, 2000; Gee, 2000). Tucker-Raymond et al. (2007) discuss how children in elementary school start developing science identities as they imagine themselves as scientists. “They [students] cannot become people whom they view are impossible to become. But possibility comes from experience” (Tucker-Raymond et al., 2007, p. 561). Young students must be able to engage in practices reflective of science identities and feel comfortable doing so.

Assuming a science identity is not a simple innate feature of the self, but rather a developmental process that is undertaken incorporating self-evaluation along with reflections and feedback from others. Science identities form at the juncture of internal and external forces that include personality traits, subject knowledge, behaviors, and recognition by parents, teachers, and peers (Carlone & Johnson, 2007; Malone & Barbarino, 2009). This study has three aims: 1) to investigate how Latina adolescents seek to establish themselves as future scientists within their environments, 2) to learn how parents, teachers, peers, and others are supportive of these positions, and 3) to explain how home and school environments sustain these developing identities.

To examine this topic, I used a mixed method procedure called an "exploratory sequential design" that starts with a qualitative stage followed by a quantitative stage (Creswell & Plano Clark, 2007). The reason for collecting qualitative data initially is that there is little in the research literature about specific behaviors of others that influence adolescent Latina science identity development. The first phase of this study was a qualitative exploration of the development of science identities in older adolescent Latinas. In this phase, I used focus groups and interviews of university-aged Latinas to create conceptual maps that identify important people and processes that impact interest engagement and maintenance. In the second, quantitative phase I used survey methods to examine the prevalence and relations of these socialization factors in a middle-school adolescent Latina population.

The guiding research question of the study was how do Latina adolescents develop a science identity? Specifically, in the qualitative stage I examined: 1) What socialization factors contribute to the development of science identities in Latina adolescents? and 2) How do these factors relate to each other? For the mixed methods component, the research questions were: 1) How can these factors be categorized? and 2)

What factors emerge from the qualitative data that were not known beforehand? Following the protocol for exploratory sequential design (Creswell & Plano Clark, 2007), specific quantitative research questions and hypotheses were formulated after the completion of the initial qualitative phase and development of the taxonomy. The two research questions for this stage were: 1) What are the socialization factors identified by young adolescent Latinas? and 2) How are these factors related to science outcomes associated with a science identity?

Positionality

Merriam, Bailey, Lee, Ntseane, and Muhamad (2001) propose that positionality is how a researcher is situated in relation to the subject of their research and that this position as an insider or outsider can change over time. Identities surrounding gender, ethnicity, class, and other social identity variables become more or less prominent in different situations as researchers encounter diverse individuals and microcultures within their subject. These ideas of positionality are important because they impact power relationships and how participants are represented in the research products. As such, my own positionality regarding this study, including my personal interests and identities, should be outlined at the start of this paper.

I was a science teacher and still find myself with that identity although more and more years stretch between now and when I last discussed the periodic table to a classroom full of kids. I still listen to media reports and think, “How could I use this in a classroom?” Teaching becomes a mindset, a way of looking at the world. As I have made my first forays into college teaching, I find myself reflecting again on this identity, embracing my past experiences, but looking forward to new growth as a college teacher.

I also have another identity and that is as scientist. Science was how I was taught to evaluate, judge, and think about the world, including the people in it. As a child, I was very interested in science. I participated in science fairs, attended science summer camps, and assisted a college professor while in high school. I majored in biology as an undergraduate, with the intent to do genetic research. However, I made no personal connections to professors in my major and had little research experience. I did not continue onto graduate school partly, because I did not know who to ask for references. As I had a part-time job tutoring high school students and education was a common profession in my extended family, I decided to earn my teaching credential in secondary school science. My dream, however, was always to return to school and earn my Ph.D. Now as a graduate student, I am crafting my identity as a social scientist, and grappling with how that is different and how it is the same as being a "real" scientist.

These are my occupational identities, but my social identity is as a White, upper-middle class, heterosexual female. I try and remain conscious of the social privileges these multiple identities award me. I was born and raised in Chicago, a city known for both its ethnic diversity and its neighborhood segregation. I attended public schools where whites were a minority and I had friends of various racial and ethnic identities. As such, my racial identity was salient to me at a young age and, while I am sure I had conceptions about race that would make me cringe now, I believed early in racial equality. These beliefs became more salient when I went to college and experienced some culture shock adapting to a white-majority school with a limited urban presence.

I also identified early as a feminist and was aware that my interest in science was not gender-typical. However, I was encouraged by my family in my interests and through my school, I was introduced to additional afterschool and summer science activities. When I entered college, I was particularly aware of my gender identity within physical science classes where I was one of a handful of female students. I felt like I had to hide, not wanting to bring attention to myself as different from other students. These beliefs undoubtedly contributed to the difficulties I had making connections with peers and professors in these classes.

My experiences and beliefs have led to a personal commitment to social justice. I know I am an outsider to communities of color and I struggle with how my work can address inequities for communities of which I am not a part. Part of my solution to this problem is to root my research in foundational theories that examine psychological processes and educational systems through critical and ecocultural lenses. I also want to retain a critical eye on structural systems that perpetrate inequalities, looking beyond deficit models that place fault on cultural and individual factors. I believe that using an eco-cultural theoretical lens allows for the system to be examined in conjunction with individual, psychological variables. The following section describes in more detail the three major theoretical foundations—ecoculural development, cultural psychology, and critical race theory—that form the basis for my study.

Philosophical Foundations

Ecoculutral development looks at the cultural settings of development. Major proponents of the theory are Super and Harkness (1986; 1999), who developed the idea of a "developmental niche." In this theory, the settings of a child's life, cultural childcare practices, and the psychology of caregivers all interact to form the cultural context of child development. While initially parents are the most important part of all three components, as children enter school-age, other people and settings, such as teachers and the school system, becomes more influential. Harkness and Super believe that individual behavior is best understood by research that investigates together cultural beliefs and child settings.

Garcia Coll, Crnic, Lamberty, and Wasik (1996) criticized many of the contextually based theories of child development, however, for not emphasizing social stratification systems. Social systems such as racism and discrimination are placed on the periphery of models and their possible influence on child development underestimated. As a result much of the literature on minority child development has concentrated on deviations from white, middle-class population standards rather than normative, within group development. This has resulted in the "deficiency model" of minority research where deviations are seen as a result of either genetic or cultural deficits within the minority populations (Garcia Coll, et al.). Parents are often blamed for not socializing their child to the white, middle-class norms.

As an alternative, Garcia Coll et al. (1996) created an integrative model for the study of minority children's developmental competencies. Within this model, social factors, such as race, ethnicity, and gender are foremost not only because of their social preeminence, but because of their ability to interact with subsequent variables. Segregation, racism, and discrimination are unique environmental conditions that have a direct influence on developmental processes by creating promoting or inhibiting environments. In this model, minority communities develop an adaptive culture in response to these environmental pressures. Both the environments themselves and the adaptive culture influence child and family processes leading to developmental competencies.

While acknowledging that culture is influenced by ecological settings, cultural psychology emphasizes the interactive nature of culture and the individual (Miller, 1999). According to Miller, culture is a public, interactive meaning system and set of normative behaviors. As such, it imparts meaning on individual behavior and offers explanations for psychological observations. Cultural psychology views culture as an internal part of the self. This differs from cross-cultural psychology that treats culture as an external variable that can be controlled for or that creates a natural group comparison point (Greenfield, 2000). Cultural psychology does not look to compare groups, but rather seeks to examine processes as they arise within a culture, prioritizing the words of the participants over the researcher.

Cultural psychology shares with critical race theory (CRT) a belief that research should include the words of its participants and that it has the power to be transformative (Cole, 1991; Ladson-Billings, 2005). While not designed as a critical study, this project is also informed by CRT. CRT studies in education look to emphasize the centrality of racial experiences, to challenge existing social structures, to seek social justice, to centralize the words of people of color, and to use interdisciplinary measures (Solórzano, 1998). When studying educational system, a CRT perspective requires that the researcher forefronts the experiences of the participants of color, acknowledging their experiences of discrimination and racism. This perspective also requires that the researcher question how social structures, such as schools, maintain historical inequalities in the present day.

Yosso (2005), drawing on the work of Oliver and Shapiro (1995), also extends the CRT discussion to include an understanding of how students can have community cultural wealth that extends beyond traditional understandings of cultural capital, such as economic or educational. Community cultural wealth empowers students of color, similar to the promoting environments discussed by Garcia Coll et al. (1996). Yosso theorizes the existence of six types of community cultural wealth. Aspirational capital refers to the preservation of hopes and dreams and linguistic capital refers to the benefits of being bi- or multi-lingual. Familial capital refers to kinship bonds that impart a sense of community, while social capital refers to the maintenance of a network of support. Navigational capital refers to the understanding of the bureaucracy of social systems. Finally, .resistance capital refers to knowledge gained through challenging inequality. As Latinas develop identities as scientists, they likely draw on some of these forms of community cultural wealth.

This study seeks to integrate these frameworks in several ways. First, Latinas are the sole focus of the work, without any overt attempt to draw comparisons with White norms. By using information from both older and younger adolescent Latinas, their development is normed within their own cultural context. Additionally, interviewing Latinas who are successful in their goal to attend college allows delineation of specific adaptive behaviors and forms of cultural wealth used by these women and their methods of resiliency. Finally, while acknowledging the social forces of discrimination and racism that Latinas are facing, my study looks to examine the positive cultural competencies that Latinas create, particularly their positive self-identities. Keeping these frameworks in mind, the following sections offer a review of how previous literature has outlined science identity development, particularly within the career development literature, and how socialization factors shape that development.

Chapter 2: Literature Review

Science Identity Development

Gee (2000) proposes that when we study identity in an educational context, we are studying the "kind of person" we are recognized to be by others in society as opposed to a core, interval sense of self. Nature, authority figures, discourse patterns, and performance within an affinity group are markers of social identities and individuals establish their identities by using these markers. Thus, identity development is not a single, one-dimensional process, but a result of several overlapping and interconnected emergent ideas about the self. We concurrently develop identities of belonging in several groups that depend on our situational context and individual factors (Brickhouse et al., 2000).

Young students do not take on fully formed science identities. Rather, they engage in practices reflective of these identities and develop confidence as they perform (Tucker-Raymond et al., 2007). By engaging in science-related practices repeatedly, a science identity develops. This is why the school environment, in particular, is so important for the development of science identities. Schools allow students to engage in scientific performance, gain recognition as potential scientists from authority figures, and develop content knowledge, all requirements for developing a science identity (Carlone & Johnson, 2007). Additionally, research with college students has found that participating in science-related social structures increased the salience and commitment to a science identity (Merolla, Serpe, Stryker, & Schultz, 2012).

Drawing on the work of Gee (2000) in a qualitative study of women of color, Carlone and Johnson (2007) argue for a three-phase model of science identity. First, a person must have science competence, which encompasses knowledge of a particular science subject. Second, she or he must exhibit science performance of relevant practices including both use of specialized language and tools. Finally, the person must recognize the self as a scientist and be recognized as well by significant others as a scientist. The study by Carlone and Johnson highlighted the importance of the third factor, recognition, in women of color's experiences in science. The authors report that women of color had "feelings of alienation and invisibility" in college science classes. These undergraduate students who were not recognized as potential scientists either by the college establishment or by significant others, such as family or community members, found it more difficult to develop a science identity and found their career paths in science to be disrupted. These students also recounted experiences of either sexism, racism, or ethnocentrism from powerful others within the university.

Support for the importance of recognition in the development of a science identity can also be found in work by Malone and Barbarino (2009) that looked at the development of science identities for science graduate students of color. They found that these students were subject to feelings of isolation and marginalization, often due to their status as "the only one" of their race or ethnicity in the laboratory. Yet, they were also able to feel value through their work and contribution to a scientific laboratory. These students were encountering conflicting recognition patterns. Recognition based on race or ethnicity contributed to a feeling of marginalization, while recognition for science performance was connected with inclusion into the scientific community.

A caveat to the identity theory of Carlone and Johnson (2007) is how individual psychological differences may influence the formation of a science identity. For example, in a qualitative study of two African American girls' science experiences, Brickhouse and Potter (2001) found that the girls experienced marginalization in science and computer classrooms, especially when the classes were white-dominated. However, one of the girls was better able to adapt to the classroom culture because of her willingness to engage with other students. This student was also more willing to take on parts of an identity that were not gender-normed, such as being vocal in class, which positively impacted her performance in her computing classes.

Individual differences can help explain how people react differently to similar circumstances. Someone who is more outgoing and more willing to cross social boundaries may have an easier time developing and maintaining the science identity necessary for advanced work. This may be because they are more willing to take performance risks—using specific language or tools—that help develop confidence as people learn through doing. Alternatively, people with more outgoing personalities may be more readily remembered and thus recognized by others. Therefore researchers need to recognize that similar contexts may still lead to different science identity outcomes based on individual differences.

Occupational identities and interests

Children and young adults often assume student identities that transition into occupational identities. An adolescent who develops an interest in science can later foster an identity as a scientist. While educational researchers tend to focus on interest in science as a school subject area, vocational researchers focus on interest in science as a career. As the ultimate goal of this work is to examine the development of science identities, the following section will focus on interest as conceptualized in the occupational development literature.

Children form vocational interests during the middle school years that tend to persist throughout their lives and this stability appears to be common across various ethnic groups (Low, Yoon, Roberts, & Round, 2005; Tracey & Robbins, 2005). Eighth graders who expected to have a science career by age 30 were 1.9 times more likely to graduate with a life science degree and 3.4 times more likely to graduate with a physical science/engineering degree than those without early science career goals (Tai, Liu, Maltese, & Fan, 2006). Middle school appears to be a key time for the formation of career interests.

However, several researchers have found that while students express positive attitudes toward science in general (Forgasz, Leder, & Kloosterman, 2004; Georgiou, Stavrinides, & Kalavana, 2007), there is less interest in science as a career (Turner & Lapan, 2002). This is a special concern for women. Several studies point to little difference in adolescent male and female attitudes toward math and science as academic subjects (Forgasz, Leder, & Kloosterman, 2004; Georgiou, Stavrinides, & Kalavana, 2007; Andre, Whigham, Hendrickson, & Chambers, 1999; Greenfield, 1996). However, when math and science interests are investigated from a career perspective, gender differences are found.

Most of this work has investigated gender differences using Holland's RAISEC occupational themes (1997). In this theory, individuals express varying levels of six different personality types—realistic, investigative, artistic, social, enterprising, and conventional—that are matched with career environments that encourage expression of these different traits. The realistic and investigative types typically encapsulate STEM interests. People who express realistic traits identify as practical, self-reliant, and like to work with their hands. People who express investigative traits are analytic, independent, and like to investigate problems. Both types typically prefer to work with things or ideas rather than work directly with people. While scores on each subscale vary independently, most people with STEM interests have high ratings on the investigative or realistic scales (Gasser, Larson, & Borgen, 2007).

Realistic career interests have shown some of the greatest gender-related differences with reports that boys have higher self-confidence in, have higher expectations for, and have more interest in these careers than girls (Lapan & Jingeleski, 1992; Tracey & Ward, 1998; Turner & Lapan, 2002). This difference holds for students in elementary, middle, and college samples (Tracey & Ward, 1998). Boys also display greater expectations for higher prestige Investigative careers (Lapan and Jingeleski, 1992). Gender and career-gender typing were found to predict interests in Realistic, Investigative, and Social careers (Turner & Lapan, 2002).

Other investigations not based on RAISEC scores also find gender differences in STEM career interests. Studies by Zarratt and Malanchuk (2005) and Watt (2006) have found gender to be a significant predictor of interest in or actual college major for students even after accounting for other variables such as socioeconomic status, beliefs in science ability, and academic achievement. Gender also appears to influence what type of science people choose to pursue. Bleeker and Jacobs (2004) found significant gender differences in the choice of careers in a longitudinal cohort study where 5% of females chose a physical science/computing career while over 14% chose a career in life science or business. Reigle-Crumb and King (2010) also found that men dominated physical sciences and engineering majors, but biological sciences had an equitable distribution. While girls and boys report liking math and science equally, they do not equally look forward to math and science careers. We now turn to theoretical models for possible explanations and how socialization might contribute to these differences.

Expectancy-value theory and occupational choices

Eccles (1987; 1994) created an expectancy-value model of achievement-related choices that has been used extensively in the study of women's academic and career choices. This model emphasizes the importance of a person's choices and contextual variables, including socialization, in addition to internal characteristics in the development of career interests. In Eccles' model, a person chooses between possible roles, classes, skills, and talents to develop. These choices may be based on societal expectations and stereotypes, a logical evaluation of the self, or a combination of both. Eccles was concerned that previous models restricted the reasons behind career choices made by women to deficit psychological characteristics (1994). Deficit models focus on the choices people are not making and limitations they may experience rather than the agency of the individual. In contrast, Eccles focused her theory on the choices women make working within an expectancy-value motivation framework, creating a "neutral model" that recognizes the influence of gender roles while also allowing for agency of choice. In this model, people choose careers that have high personal value and in which they have high expectations of success. Both values and expectations, however, are influenced by previous experiences and socialization.

Eccles' theory (1987; 1994) attempts to establish that career choices are not made in the vacuum of the self, but within a context and among other choices. So, for instance, a girl who chooses to take an advanced English course over an advanced math course may not be doing so because she has low self-efficacy in math. This would imply a deficit framework. Instead, the student makes an active choice based on her value system at the time. For example, she might have friends enrolled in the English class, but not the math class. If she places a high value on maintaining her friendships, she may choose to take the English class. These values and expectations are formed based in part on socializers' beliefs and behaviors and the cultural context, such as societal stereotypes and expectations. In Eccles' work, significant others and cultural context indirectly influence expectations and values through internal cognitive processes and ability self-concepts.

One way that stereotypes can influence internal cognitive processes is through stereotype threat. Stereotype threat is a psychological phenomenon in which individuals of stereotyped groups, in an effort to not conform to a negative stereotype, find their performance suffers on a stereotyped task (Spencer, Steele, & Quinn, 1999; Steele & Aronson, 1995). Members of the group perform worse on tests than their actual ability would indicate. To demonstrate this phenomenon, individuals must first be aware of the societal stereotype. They must also have a high stake in the results, either through a personal motivation to excel or because of an external reward based on performance, such as entrance to college. Thus, stereotype threat disproportionately affects those who feel they have the most at stake with the testing (Steele & Aronson, 1995).

For adolescent women of color who have an interest in science, they might struggle with the double stereotype that both women and students of color are not academically gifted in science. In a downward feedback spiral, if stereotype threat then adversely affects their test scores or class performance, these young women are likely to be kept from entering college-track science classes, which then impacts their educational experiences, which would then impact their motivations, affect, and cognitions about science (Ryan & Ryan, 2005).

Social-cognitive career theory and self-efficacy

Lent and colleagues proposed an alternative theory to explain interest development and career choice that also recognizes contextual variables, named Social-Cognitive Career Theory (SCCT; Lent, Brown, & Hackett, 1994; Lent & Brown, 1996; Lent et al., 2001; Lent et al., 2005). The theory is constructivist in nature, assuming that people are actors in developing their own interests and interacting with the environment. Based on Bandura's (1977) social-cognitive theories of motivation and incorporating many of the ideas of Betz and Hackett (1981), SCCT proposes that interest develops as a function of the interplay between three variables of causality—person attributes, environmental influences, and overt behaviors.

The variables of person attributes, influences, and behaviors parallel the three factors identified by Carlone and Johnson (2007) in the development of science identities—subject competence, recognition, and performance. However, while Carlone and Johnson (2007) emphasize the recognition aspect, SCCT (Lent, Brown, & Hackett, 1994; Lent & Brown, 1996), emphasizes person attributes, particularly self-efficacy beliefs, as the most significant direct influence on occupational beliefs. Self-efficacy refers to a person's own beliefs about their agency to produce desired results (Bandura, 1989). The beliefs are context and domain specific, so that a person may have different self-efficacy beliefs about their ability to perform well on a written science test versus a laboratory science test. These beliefs are not static, however, and are highly influenced by personal performance on related tasks. Vicarious learning and social influences also theoretically impact self-efficacy, but these influences are not thought to be as strong (Lent, Brown, & Hackett, 1994).

The influence of self-efficacy on interest has been supported in the literature (Rottinghaus, Larson, & Borgen, 2003). Specific to STEM, children's own self-perceptions of their ability in math and science is predictive of grades and later career choices (Jacobs, 1991; Bleeker & Jacobs, 2004; Lent et al., 2001; Lent et al., 2005; Turner, Steward, & Lapan, 2004). In a Mexican American middle school sample, STEM self-efficacy predicted STEM interests and both were predictive of goals intentions in math and science courses and careers (Navarro, Flores, & Worthington, 2007). Lent et al. (2001) found that math and science interests in a college-aged sample were predicted by both self-efficacy and outcome expectations.

However, significant differences between genders and ethnic groups have been observed when studying self-efficacy. Kurtz-Costes, Rowley, Harris-Britt, and Woods (2008) found that while middle school girls rate their own gender as more competent in math and science classes as a group, they also have significantly lower self-perceptions of their own math and science abilities than boys. Adolescent females appear to endorse that anyone, regardless of gender, can be good at math and science, but that they themselves are not one of those that are good. In particular, Mexican American girls have less math and science self-efficacy than Mexican American boys (Navarro, Flores, & Worthington, 2007), while Latino students in general have lower mean levels of perceived math and science competence compared to European-American students (Bouchey and Harter, 2005). Going beyond simple demographic comparisons, Gushue and Whitson (2006) found that ethnic identity had a direct and positive relation with career-decision making self-efficacy and that self-efficacy mediated the role of ethnic identity on career planning outcome expectations. Students with greater positive feelings toward their own ethnicity and self abilities were more likely to feel confident about their career decisions. However, additional explanations for these gender and ethnic differences remain to be tested.

One of the strengths of SCCT is that it maintains gender and ethnicity as socially-created constructs that shape exposure to activities, the reactions of significant others, and outcome expectations. Gendered activities, such as playing house or building trains, are common even for pre-school age children as parents distinguish between boys and girls in their encouragement of sex-typed activities (Lytton & Romney, 1991). Children who try gender-nontraditional activities may be either supported or opposed in their efforts and these reactions may then contribute to their persistence in the activity. In addition, as children grow older and more cognizant of social norms, they may be more likely to identify social barriers to their pursuit of specific interests. Knowledge of barriers may then lower outcome expectations and hinder goal setting, both of which lead to loss of interest.

In summary, theories of vocational development developed by Eccles (1987; 1994) and Lent and colleagues (Lent, Brown, & Hackett, 1994; Lent & Brown, 1996) have mainly stressed the cognitive and motivational aspects of the process in which an individual appraises his or her own abilities. The theories agree that contextual factors have significant indirect effects on interest development through cognitive processes. However, by emphasizing cognitive processes, studies of vocational interest have neglected to investigate which contextual factors are of primary importance and the magnitude of their role. This is crucial as science identity theories alternatively emphasize socialization factors such as recognition and performance (Carlone & Johnson, 2007). The following sections will review research that looks at how socialization factors may be influencing science identity development for adolescent Latinas.

Socialization and the development of science interest

Socialization is an interactive process in which "individuals are assisted in becoming members of one or more social groups" (Grusec & Hastings, 2006, p. 1). People are socialized to display a variety of behaviors, emotions, and cognitions, both by intentional and unintentional goals of the socializing agents. Grauerholz and Swart (2012) note that most researchers see the socialization process as reciprocal, in that agents such as parents and teachers, are as influenced by the child as the child is influenced by them. This constructivist view of socialization also emphasizes the agency of the individual. While powerful others may have major influences on a child, the child has the agency to make individual choices. Grauerholz and Swart, however, do caution that the social structure itself can impose constraints on the agency of an individual.

Role of family

The family is the major socialization agent for Latino families, as with most other cultural groups (Garcia Coll, Meyer, & Brillion, 1995). Children are socialized by parents, grandparents, siblings, and extended family members to appropriate cultural values and norms. Behaviors, such as academic and career choices, are the expression of culturally constructed ways of understanding the world and the self (Harkness & Super, 2005). Thus, cultural values may influence the career development of adolescents by providing scripts or paths of acceptable choices and behaviors.

For example, cultures that endorse traditional gender roles may also influence vocational interests by encouraging a division of male and female responsibilities. A girl highly socialized and accepting of that cultural norm may then be unlikely to view STEM careers as congruent with their gender roles as these careers are not typically associated with family-friendly policies. A review of family influences on career development (Whiston & Keller, 2004) support the hypothesis that psychological family-related variables, such as perceived parental attitudes, have a stronger effect on vocational development for middle school students than demographic variables, such as socio-economic status and ethnicity.

For Latino families, a major value that may influence the socialization of careers is familismo. Familismo refers to the ability to get along with the family, offering of mutual support to family members, and reliance on each other (Sabogal, Marin, Otero-Sabogal, VanOss, & Perez-Stable, 1987). These values are highly endorsed by most Latinos, including Latinos who have become acculturated to U.S. White society (Sabogal et al.). Fuligni, Tseng, and Lam (1999) found that Latino high school students reported strong value and expectation levels regarding their duty to respect and assist their families. These values were associated with increasing academic motivation, but not school grades.

There is some evidence for different socialization patterns for boys and girls in Latino families. Zarate and Gallimore (2005) found a link between parental expectations and Latinos enrollment in college, but the same relation was not found for Latinas. Valenzuela (1999) in interviews with children from Mexican immigrant households found that girls were given household tasks that involved more responsibility and more social contact than boys. Children hold vital roles in helping immigrant families interact with their new communities, for example by serving as translators for parents. If girls are socialized within this role as family helper, they may be less likely to seek a career that requires leaving home. Raffaelli and Ontai (2004) also found that, in Latino families, boys are allowed more freedom to explore outside the home, while girls are more limited in their permitted environments. This matched with the study by Alfaro et al. (2008) who found that perceived discrimination was a factor for the academic motivation of Latino boys only. They surmise that because boys are socialized to a greater awareness of society outside of the family, they are more susceptible to contextual barriers to achievement.

Parents. In general, parents' academic values predict children's values and occupational aspirations (Bleeker & Jacobs, 2004; Jacobs, Chhin, & Bleeker, 2006; Jodl et al., 2001). More specifically to STEM, parent beliefs concerning the importance of math and science were predictive of middle-school students' own perceived importance of math and science, their math and science competence, and their performance in math and science courses (Bouchey & Harter, 2005). Parents' beliefs about their middle-school children's competence in math and science are predictive of both the child's self-perceptions of their own math abilities, controlling for math grades (Jacobs, 1991) and their children's math and science self-efficacy two years after high school (Bleeker and Jacobs, 2004). A more recent study by Harackiewicz, Rozek, Hulleman, and Hyde (2012) found that when parents were provided with simple resources about the benefits of STEM careers, their high school aged children took more math and science classes.

Studies that measure children's perceptions of parental attitudes find similar relations to studies that measure parent attitudes directly. Bouchey and Harter (2005) found that middle-school students who perceived that their parents thought they were competent in math and science were more likely to feel competent in math and science. Perceived parent support accounted for close to a third of the variance in vocation self-efficacy related to specific Holland vocational themes (Turner & Lapan, 2002). Additionally, perceived parent support is a predictor of vocational self-efficacy (Keller & Whiston, 2008) and specifically a predictor for STEM career interests for rural adolescents (Lapan, Hinkelman, Adams, & Turner, 1999). With parents perceived by students as encouraging math and science experiences, students reported higher interest in math and science careers and higher grades in math and science classes (Ferry, Fouad, & Smith, 2000).

While these studies show how parental beliefs can positively impact child outcomes, parental influences need to be considered with caution as parents may also impart negative perceptions. This has been studied most extensively in regards to gender attitudes. Andre et al. (1999) found that parents of children in fourth through sixth grades perceived science as more important for boys than girls, that boys were more competent in science, and that higher academic performance in science was expected of boys than of girls. In an older study, Jacobs (1991) found that parents of girls who held more gender stereotypes appear to underestimate their daughter's math ability compared to parents of boys, controlling for the child's actual ability scores. Bleeker and Jacobs (2004) found no relation between male adolescents' later career choice and their mothers' predictions of success in math-related careers, but female adolescents with mothers reporting low predictions were highly unlikely to choose a science related career. Jacobs et al. (2006)

also found that a parent's gender-typed occupational expectations of their 15-year-old child were significantly related to their child's actual career choice at age 24. Additionally, Fulcher (2010) found that mothers with nontraditional gender attitudes had daughters with nontraditional occupational aspirations. These studies, however, do not examine specific behaviors, or verbal messages that parents use to transmit their attitudes to children and thus influencing child outcomes. New studies need to examine the mechanisms and processes through which parents encourage their child's development of a science identity.

There is limited research on how Latino parents engage in these socialization processes, particularly surrounding science. Several researchers have documented that Latino parents, regardless of socioeconomic or immigration status, hold positive educational attitudes. Latino parents believe in the importance of education, provide help with children's homework, and encourage high aspirations (Okagaki, Frensch, & Gordon, 1995; Delgado-Gaitan, 1992; Suizzo et al., 2012). Azmitia, Cooper, and Brown (2009), using a small sample of Latino youth, found that parents and siblings provided the most support and guidance during the transition between elementary and middle school and that levels of parent support and parent guidance predicted math grades. In another study, academic achievement of Latino students was positively related to parental encouragement (Martinez, DeGarmo, & Eddy, 2004).

Plunkett and Bámaca-Gomez (2003) looked at the relation between gender, acculturation, parenting involvement variables, and educational outcomes for a sample of high school students whose parents were all from Mexico. In general, parental monitoring and supportive behaviors were both related to motivation and aspirations in the regression analyses. The authors believe that adolescents with supportive, monitoring parents have higher self-esteem and self-efficacy which results in higher aspirations and motivation. Additionally, they found that Latinas and those who described more English language use in the home reported higher levels of academic aspirations and motivation. Although researchers were not able to fully test their hypothesis, the authors suspect that an interaction exists between parenting behaviors and child gender on academic outcomes. Parents may be differently treating their male and female children resulting in differences on academic measures.

Siblings and kin groups. Siblings and extended family members are also a possible influence on academic and vocational development. Studies have examined kinship within an academic context and found support for the influence of kin groups. Pallock and Lamborn (2006) report that extended kinship ties were related to a stronger work orientation. Significantly, the qualitative study by Kenny et al. (2003) found that perceived kin support was associated with aspirations and expectations of career success for urban, minority adolescents. Pérez and McDonough (2008) also found that college choice for Latino college students was highly influenced by siblings, cousins, and other extended relatives. However, I found no research that documented the role of extended family members in vocational or identity development for the Latino population. This is an important gap that will be addressed by my study, especially considering the importance of extended kinship ties in the Latino community (Garcia Coll et al., 1995).

Role of teachers

The school is one of the most salient environments for children's development. Garcia Coll et al. (1996) contend that schools may act as either inhibiting or promoting environments on child development, depending on if school goals are congruent with child and family expectations. Unfortunately, many Latina students face systematic discrimination in the public school system (Miksch, 2008; Oakes & Saunders, 2004). A survey study of 6th through 12th grade Latino students found that institutional barriers, defined as school dissatisfaction, unwelcoming experiences, and discriminatory experiences, were predictors of both GPA and drop-out likelihood (Martinez et al., 2004).

Positive student-teacher interactions have been linked to increased educational planning and academic achievement (Cooney & Bottoms, 2003; Brown & Campbell, 2008). Bouchey and Harter (2005) found that when students felt teachers thought they were competent in math and science, their self-efficacy and performance both increased. Perceived support from teachers also had a direct effect on performance above and beyond the effect of parents. Garcia-Reid (2007) found that teacher support offered the greatest contribution to the school engagement of middle-school Latinas, greater even than parent and peer support. Teacher support is also a better predictor of academic satisfaction and grades for Mexican-origin youth than parent or peer support (Plunkett et al., 2008). Good teachers not only provide content knowledge, but can provide valuable feedback on skills and help students navigate the school system. Teacher support may be especially important for students with parents unfamiliar with the American educational system.

In addition to academic development, vocational development also appears to be influenced by teacher support. In a longitudinal study by Helwig (2004), students in the 10th grade regarded their parents as most influential in their career decisions, but by 12th grade, the same students nominated teachers as the most influential. Vocational advice from teachers was also cited as a means of support by urban, high school students in a qualitative study (Kenny et al., 2007). Metheny, McWhirter, and O'Neil (2008) found that students who perceive their teachers as caring and more invested in their future reported higher levels of career decision-making self-efficacy and higher outcome expectations. These studies all point to the overall positive effect of teacher encouragement on student career development, but they are not subject specific. What remains to be documented is the specific behaviors of supportive teachers that directly influence students' science interests and identities.

What also needs to be examined is how Latina students may be facing unequal access to high quality teaching and mentorship. Latina students are likely to be taught by teachers with less experience and less subject knowledge, both key characteristics of quality teachers (Betts, Ruenben, & Danenberg, 2000; Fuller, Carpenter, & Fuller, 2008; Teranishi, Allen, & Solorzano, 2001). Most importantly, the level of teaching experience and the percentage of teachers without a full credential within a school are strongly related to student achievement in that school (Betts et al., 2000; see also Bolyard & Moyer-Packenham, 2008). Schools with the highest levels of experienced and credentialed teachers had the highest student achievement. Teachers not only provide the recognition necessary to develop a student's science identity, but are linked to science competence as well.

Role of school resources

Access to advanced math and science classes is a resource problem faced disproportionately by minority and low-income students. Latinos, especially at low-income schools, have less access to math and science classes that are included on pre-college tests and are necessary for college entrance (Adelman, 2006; Oakes & Saunders, 2004). In addition, high schools that serve predominantly Latino students have low enrollment in AP classes and, even in schools with high AP enrollment, Latino students were disproportionately under-represented in the AP classes (Solorzano & Ornelas, 2002; Teranishi et al., 2004).

Within the same schools, Latinos and Whites are tracked into different classes with different consequences for their college eligibility. Only 24% of Latino graduates from White majority schools met the minimum admission standards to the top state schools as compared to 35% of White graduates at the same schools (Teranishi et al., 2004). Crosnoe (2009) found similar results using a national data set that documented how low-income students, especially African American and Latino students in schools that have white majorities, are tracked into lower-level math classes than their peers.

In conjunction with inadequate access to advanced class work, Latino students are likely to face problems with access to quality curriculum and classroom materials. At schools with a large percentage of students of color or low-income populations, curriculum is disproportionately text-based, remedial, and teacher directed, as opposed to more activity based and student centered (VonSecker & Lissitz, 1999; Oakes, 1990). These types of vocabulary-heavy curriculum pose special problems for ESL students or other students with different cultural discourse patterns (Lee & Buxton, 2008). Teachers and counselors may mistake student reluctance to pose questions or difficulties with translation as problems with content knowledge or student ability.

Principals and teachers in low-income schools also report that material resource problems interfere with adequate science instruction (Oakes, 1990). A Harris Research Poll of elementary and secondary science teachers in California found that 49% of science classes lack laboratory equipment and the resources to do laboratory work (Oakes & Saunders, 2004). Schools with large numbers of students on state aid or with large numbers of English language learners were among the lowest rated (Oakes & Saunders, 2004). These same schools also reported having poor quality textbooks in insufficient numbers to send home with students. Teachers even reported having science "laboratories" with no access to running water to conduct experiments or clean equipment. In addition, schools with high numbers of minority students have higher computer-to-student ratios than schools with low minority enrollment (Wells & Lewis, 2006). Nonetheless, access to such equipment is required in order to learn state content standards that constitute the basis of achievement tests.

Previous research has defined barriers broadly to include areas such as family support, financial constraints, racial and gender discrimination, and job market pressures (Lent et al., 2001). However, inadequate school resources are also a possible barrier. Lack of materials is an important problem as theories acknowledge the importance of performance in the development of science identity (Carlone & Johnson, 2007; Gee, 2000). Schools have the very important responsibility to engage children in activities they do not have access to at home. At schools, students are given the chance to perform, try, and act on different abilities. This is why it is imperative to address not only encouragement from school personal, but also school activities. Without an opportunity to engage in science, children will not form positive expectations about their future abilities in science (Tucker-Raymond et al., 2007). With schools attended by Latinas often under-supplied and inadequately staffed, we must consider the consequences of these environmental factors on student identity development.

Socialization as a system

While the previous sections individually addressed the major factors theorized to play a role in science identity development, the system aspect of these socialization factors needs to be emphasized. It is not a single factor that produces a science identity, but a range of pressures and incidents that interact with cognitions about the self and affective moments to engage a socially constructed identity. This ecocultural approach to identity (Cooper & Denner, 1998) has found some support in research studies that attempt to sample a range of contexts in investigating science interests and career choices. Archer et al. (2012) found that children's science aspirations were best predicted by a combination of parental attitudes toward science, experiences of school science, and science self-concept. Additionally, Stake (2006) found evidence that support from parents, teachers, and peers was a stronger predictor of science interests than gender, ability, or parent's educational level.

More specific to this research, Navarro, Flores, and Worthington (2007) examined variables that explained the STEM goals and expectations of middle-school Mexican American students using the SCCT framework. Perceived social support from parents was a significant predictor of STEM self-efficacy, but perceived support from teachers, classmates, and friends was not. Interestingly, while Mexican American girls had less math and science self-efficacy than boys, gender was not a statistical moderator of the relations in their model. However, the study conceptualized contextual influences as perceived social support and family SES, leaving unaddressed more school-level material influences. The authors do mention the possible role of access to learning experiences as socio-economic status was indirectly related to self-efficacy through academic performance. New research needs to address this limitation as learning opportunities offered within the school system are likely important predictors of interest.

In a study that specifically addressed adolescent Latina career interests, Flores and O'Brien (2002) surveyed a sample of Latina high school students, predominately Mexican-Americans. In this study, Latinas who were less acculturated and less likely to endorse feminist attitudes were more likely to endorse interests in traditional female-dominant careers. However, nontraditional career self-efficacy and nontraditional career interests were not predicted by any of the hypothesized predictor variables of acculturation, feminist attitudes, mother's education level, and mother's occupational traditionality. This study then leaves open the question of what factors are predictive of nontraditional career choices for Latina adolescents, a question that the current proposed study will address.

Chapter 3: Methods

The overall aim of this research study was to understand how Latina adolescents position themselves to develop and maintain science identities. I employed a mixed methods, sequential, exploratory design with taxonomy development model in which a qualitative phase is followed by a quantitative phase (Caracelli & Greene, 1993; Creswell & Plano Clark, 2007). Also known as a *sequential mixed design* (Teddie & Tashakkori, 2009), this type of study has two strands where the research questions from one strand are dependent on the previous strand (see Figure 1).

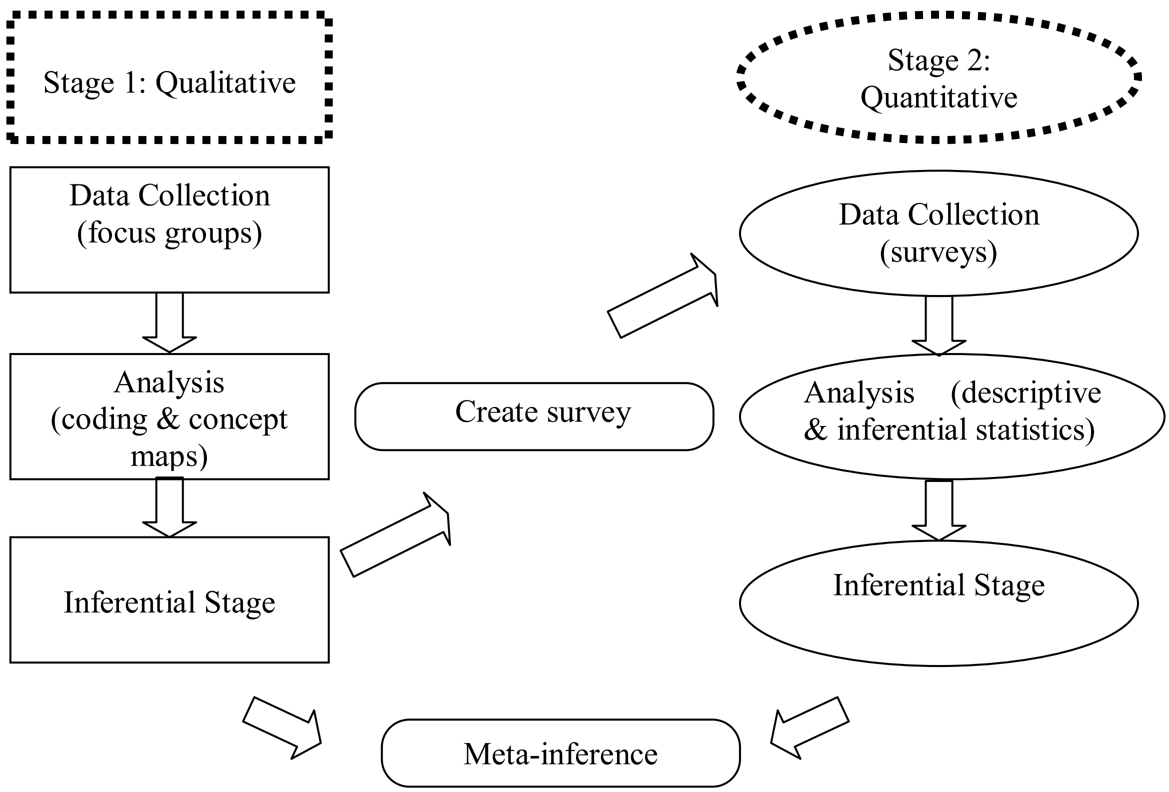

Figure 1. Diagram of mixed methods study components based on graphics created by Teddi & Tashakkori (2009). Rectangles represent qualitative components, ovals represent quantitative components, and rectangles with rounded corners represent areas of overlap.

In this design, researchers first collect qualitative data on a phenomenon and then identify important variables in order to develop a taxonomy that describes the phenomenon. Based on the categories and relations identified in the first phase, the second, quantitative phase examines the prevalence of these categories within another sample. Thus, specific research questions and hypotheses for the quantitative phase are based on the specific findings from the qualitative phase. The two phases are connected at the intermediate step of the study and the final inferences are based on results from both strands. The rationale for this approach is that the exploratory design identifies important variables to study quantitatively when previous research has not yet resolved these variables and well-established measures of the phenomenon have not yet been developed (Creswell & Plano Clark, 2007). This design is also used when the guiding theory and framework are still emerging.

While this design requires two different data collection procedures, a mixed methods project is the best way to address how adolescent Latinas develop science identities. Scales cannot detail the experiences of people and case studies cannot address the prevalence of experiences; a mixed methods study can do both. Mixed methods research is also practical in that when we look at a problem, such as the low numbers of Latinas in STEM, we tend to see the problem both in terms of statistics and in terms of personal narratives (Creswell & Plano Clark, 2007). With a mixed methods approach we can describe and approach the problem using our natural tendency to combine both numbers and stories.

Teddi and Tashakkori (2009) note that mixed methods research allows a researcher to both construct and verify theory within the same study. By combining both qualitative and quantitative methods we can identify influential factors and test for the prevalence of these factors. A mixed methods study of this type offers the advantage of having relevant qualitative findings to help explain potentially surprising quantitative findings. Additionally, mixed methods research can provide stronger conclusions if both the qualitative and quantitative data are consistent, providing an internal check of validity (Creswell & Plano Clark, 2007; Teddi & Tachakkori, 2009). From my review of the field, a true mixed methods approach has not yet been undertaken on this problem and as such, this study has the potential to add significantly to the research literature. Additionally, from a practical standpoint, Teddie and Tashakkori (2009) note that this sequential exploratory methodology is one of the least complicated mixed methods designs for single investigators to conduct as the data collection for each strand occurs separately.

This study followed the guidelines established by the Institutional Review Board for the Protection of Human Subjects at the University of Texas, Austin. Please see Appendix A for copies of the consent forms for both Stage 1 and Stage 3. As Stage 1 was for students over 18 years of age, only their written consent was required. However, Stage 3 required both written consent from parents and an assent form from the students.

Stage 1: Qualitative Analyses.

Research questions. The qualitative stage of this study was guided by two research questions: 1) What socialization factors contribute to the development of science identities in Latina adolescents? and 2) How do these factors relate to each other?

Participants. In Stage 1, undergraduate Latinas enrolled as science, technology, engineering, or math majors at the University of Texas, Austin participated in focus groups and interviews. While not yet fully engaged in a scientific occupation, these students' presence on campus in a STEM major does represent an additional step along the pipeline to a STEM career. Additionally, their closeness in time to previous schooling at the middle school and high school level makes them more likely to recall details of relevant influences.

Participants were recruited by contact with student groups, advertisements posted around campus, and subject pool assignments, with a special effort to recruit students in physical, computer, and earth sciences and engineering. Thirty-two students met in seven focus groups. Twelve different students participated in individual interviews. All focus group meetings and interviews were audio recorded and transcribed.

Including both focus group and interview students, almost 70% of the sample had either junior standing or above with an average age of 20.79 years old (*SD* = 2.02). For those that reported their information, nutrition was the most common major (N = 8), followed by human development and family sciences (N = 7) and biology (N= 7). Five participants were engineering majors, although they all differed in their area of specialization. Two students were majoring in chemistry, two in biochemistry, and one in mathematics. One student majored in each of the following: computer science, business engineering, environmental science, kinesiology, psychology, microbiology, and management information systems. Two students majored in communication sciences and disorders. Two were undeclared, but were students in the College of Natural

Sciences. The majority of students planned on attending graduate school (65%). Their average grade point average was 3.09 (*SD* = .52).

While two-thirds of participants were born in the U.S. (N = 33), a slight majority of participants spoke Spanish as their first language (N = 22) and three of the remaining participants spoke both English and Spanish as their first languages. For 58% of participants, both their mother and father were born outside of the U.S. Mothers of participants had various levels of education with 14% having less than a high school diploma, 28% with a high school diploma, 28% with a college degree, and the remaining 30% having some college classes or an associate's degree. For fathers, 12% had not completed high school, 39% had a high school diploma, 19% had some college or an associate's degree, and 30% had a college degree.

Procedure. The format of the focus group was based upon the Interactive Qualitative Analysis (IQA) method developed by Northcutt and McCoy (2004). The purpose of the IQA methodology is "to describe both the elements and the relationships of social systems in such a way as to delineate the patterns of influence among the elements" (Northcutt & McCoy, p. 41). In IQA, a researcher uses focus groups with follow-up interviews to identify the components of a phenomenon and their relationships to each other. These are depicted on a concept map, a visual representation of the phenomenon as seen by the participants.

The advantage of basing the qualitative stage on the IQA methodology is both practical and philosophical. Practically, the group identification of specific themes and components allows for easier conversion to strong survey items within the second stage of the study. Rather than creating items based on the recollections of a single participant, focus groups in IQA collectively endorse the themes. Items that are mentioned by many participants can be easily identified. Additionally, placing these themes in a relationship diagram generates hypotheses of relations to be tested in the quantitative phase.

Philosophically, I agree with the goal of IQA to describe a system as the participants experience it, especially when a phenomenon is theorized to be socially constructed. I also appreciate that the method gives participants a role in organizing the data, emphasizing their experience of the system. Additionally, because this study uses an ecocultural lens with an emphasis on how adolescents seek to position themselves within a contextual system, IQA methodology is well-suited for this study as it emphasizes an understanding of a system from the participants' perspective. My interest was not in a cross-cultural comparison on Latinas with other groups; rather I sought to identify themes and processes operating within a single community, an approach taken by cultural psychologists (Greenfield, 2000).

After obtaining consent forms from participants, I began the focus groups with a guided imagery exercise designed to have students reflect on their science identity development. (See Appendix B for a specific outline of the focus group protocol.) Participants were asked to remember events that occurred prior to college enrollment and specifically address behaviors and attitudes of significant figures, such as parents, teachers, peers, and extended family. Participants were also asked to consider events, particularly in school contexts, that engaged their interest. On index cards, students individually wrote words and phrases that represented their reflections. Participants then shared these cards with the group, providing clarification as to meaning when necessary. After everyone has had the chance to share, participants grouped the cards together on a wall to produce a visual categorization of responses.

When a majority of the cards had been moved into categories, I guided the group in developing names for these categories, or "affinities" in IQA. At this stage, participants were engaging in a rudimentary creation of themes, a part of qualitative research that is usually done alone by the researcher (Marshall & Rossman, 2011). See Figure 2 for a photo of one focus group's card grouping. The focus groups ended with a general discussion about the relative importance of the groups and questions about the influence of gender and ethnicity on their science identity development.

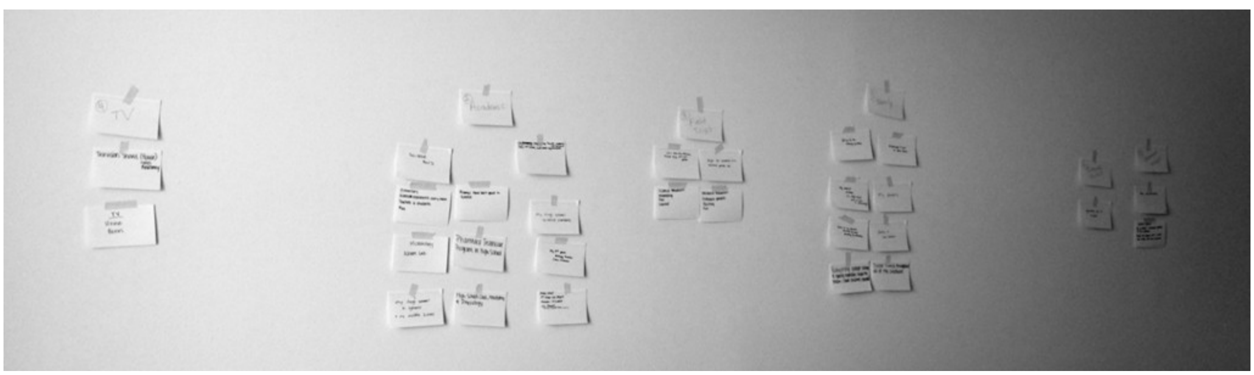

Figure 2. Photograph of a focus group's arrangement of cards. In this photo, students arranged their cards into the groupings entitled *TV, academic, field trips, family, outside factors,* and *personal interests.*

At the end of each focus group, I created a spreadsheet that listed the group identified factors and also entered each card that had been listed under that factor. When the information from all focus groups had been entered, I created a composite spreadsheet that listed all factors identified by the groups. I then examined this list, consolidating similar factors while also trying to maintain the card combinations as they were envisioned by the participants.

When I had an initial list of common factors, I then went through each index card, sorting the card into a factor to check that my factors incorporated as many of the individual cards as possible. As not all cards were initially included in this sort, I expanded some factors to incorporate a wider variety of items. For example, parent influence was expanded to home environment to include the effects of other relatives. After this process, I settled on a final list of eight common factors, or affinities.

I then conducted follow-up interviews to check that these affinities resonated with the population, obtain more complete descriptions of the affinities, and identify possible relations between the affinities. All of the focus group and interview participants were different people, so interviewees had not previously seen these affinities. In interviews, I asked participants to first verify if the theme was relevant to their story and if so, to provide examples of the affinities as they influenced their own identity development. Second, they were asked to identify any relations between affinities and provide examples of these relations, with the direction of relations noted on a handout. (See Appendix C for interview protocol). Interviews ended with open-ended questions similar to the end of the focus group, asking participants about their perception of the influence of gender and ethnicity on their development. These interviews lasted about an hour. A total of 12 interviews were conducted. In addition, I sent an email list of the affinities to focus group members and requested that they nominate relations between affinities. Two focus group participants responded to these follow-up emails and their responses are included in the analysis.

After the completion of all focus groups and interviews, the next step in the IQA process is to create a concept map of the system. This process starts with creating a spreadsheet listing all possible relations between affinities and then tallying how often participants endorsed these relations in interviews or follow-up emails. (See Table 1 in the next chapter for a list of the endorsed relations from this study.) As drawing a map that included all possible relations endorsed by all people would an unwieldy and uninterruptable web (Northcutt & McCoy, 2004), I examined this list for one or two cut-off points in drawing the concept map. Using the guidelines established by Northcutt and McCoy (2004), I looked for cut points that maximized the number of endorsed relations, that included all pairs that had been endorsed the same number of times, and that limited or excluded ties or conflicts. Ties occur when the same number of people agree that a relation exists between two affinities, but disagree as to the direction. Conflicts are similar to ties, but the number of people who disagree about the direction differs slightly. For example, eight people could endorse a relation from *media influences* to *school experiences* while seven other people could endorse a relation from *school experiences* to *media influences.* A researcher often solves a conflict either by going with the slight majority or by drawing out all possible resulting diagrams and evaluating the pathways for interpretability.

After tallying endorsed relations, I ranked the affinities in order of the number of relations endorsed coming both to and from the affinity. This allows for identification of antecedents, or "drivers", and subsequent factors, or "outcomes." When designing the diagram, drivers are drawn on the left and outcomes are drawn on the right, in order of number of relations emanating from the affinity. For example, if *home environment* was seen as influencing six other affinities, but *school environment* was seen as influencing five other affinities, *home environment* would be drawn to the left of school environment. Primary drivers are affinities in which the relations all radiate out, with no incoming relations. Secondary drivers have more relations going out than coming in. Neutral affinities have equal numbers of outgoing and incoming relations and usually sit in the middle of the diagram. Secondary outcomes have both incoming and outgoing relations, but more incoming. Primary outcomes have only incoming relations and are not seen as influencing other affinities in the system.

At this point, several preliminary concept maps, or "cluttered" systems influences diagram are usually drawn using different cut points to represent different numbers of included relations. The cluttered SIDs are then pared down to clean SIDs, or concept maps, using the steps outlined by Northcutt and McCoy (2004). (Refer to Figures 4 and 5 in the next chapter for examples of cluttered and clean SIDs, respectively.) To create the clean diagram from the cluttered diagram, direct paths from drivers and outcomes are removed if another path exists that incorporates a mediating affinity. For example, a direct path from a primary driver (*home environment)* to a primary outcome (*career planning)* would be eliminated if there exists paths from the primary driver (*home environment)* to a secondary driver (*school experiences)* and from the secondary driver (*school experiences)* to the outcome (*career planning)*. This process, while removing possible complexity, is an attempt to create a parsimonious system with greater explanatory power (Northcutt & McCoy, 2004). A final SID is decided upon that maximizes the number of relations and that provides the best interpretative explanation of the system, as determined by the researcher.

Stage 2: Mixed Methods Analysis

Stage 2 of a sequential, exploratory design as defined is the mixed methods stage. In this stage, information gathered from the qualitative stage is used to develop a taxonomy that be tested in the quantitative stage. I used the eight affinities identified in Stage 1 as the basis of this taxonomy. My aim at this stage was to create a survey for middle school students that would assess their endorsement of the different themes in their own lives and allow for an analysis of possible relations between the themes.

The survey was composed of two different types of measures. The majority of the survey consisted of previously validated scales that corresponded in content to the affinities identified in the qualitative stage of the study. Rather than create new scales with unknown validity, I included measures that had previously been used in the literature when possible. For example, to assess two affinities, teacher influences and home environment, I included the Child and Adolescent Social Support Scale (CASSS-Level 2) developed by Malecki, Demaray, Elliott, and Norton (1999). All of these scales are described in the next section about Stage 3 of the project, under survey measures. Table 1 links the affinities from the qualitative stage to the scales and measures used in the quantitative stage.

Table 1.
Affinities identified in the qualitative stage and the associated scale or measure used in the quantitative stage.

Affinity	Scale/Measure
Home environment	Parent support subscale—Child and Adolescent Social Support Scale (CASSS-Level 2; Malecki, Demaray, Elliott, & Norton, 1999)
Teacher influences	Teacher support subscale—Child and Adolescent Social Support Scale (CASSS-Level 2; Malecki, Demaray, Elliott, & Norton, 1999)
Contextual factors	Demographic information; Influences on Science Identity Inventory (ISII; Jackson, unpublished)
School experiences	District reported grades; Influences on Science Identity Inventory (ISII; Jackson, unpublished)
Media	Influences on Science Identity Inventory (ISII; Jackson, unpublished)
Emotions	Modified Attitudes toward Science Inventory (mATSI; Weinburgh & Steele, 2000)
Using your brain	Math/Science Self-Efficacy Scale, science subscale (MSSES; Fouad & Smith, 1997); Patterns of Adaptive Learning Scale (PALS)—Academic efficacy subscale (Midgley et al., 2000) modified to address science class work
Career planning	Inventory of Children's Activities (Tracey & Ward, 1998); Influences on Science Identity Inventory (ISII; Jackson, unpublished)
Additional scales used to test for possible confounding variables	Stereotype endorsement measure (Schmader, Johns, & Barquissau, 2004); Ethnic identity centrality scale (Cameron, 2004); Classmate, friend, and school support subscale—Child and Adolescent Social Support Scale (CASSS-Level 2; Malecki, Demaray, Elliott, & Norton, 1999); Demographic information;

However, not all affinities corresponded to previously validated scales, so one new measure was developed to address these factors, the Influences on Science Identity Inventory (ISII). The first draft of the scale included 15 items, divided into three areas. Eight items, corresponding to the school experiences or home environment affinities, referred to events that at least three participants had independently written about on the index cards in focus groups. For example, one item asked about participation in science fairs and another item asked about watching science-related TV shows. Three items asked about how frequently students discussed college plans with parents, teachers, and peers. These items were included to capture the general college-orientation the women in Stage 1 discussed as part of both their home and school environments. Three final items asked about how frequently students discussed science careers with parents, teachers, and peers. These items were included to capture the career planning affinity. Responses were designed to measure how often students recalled doing the activity, with five options ranging from "never" to "more than twice a month."

I sent drafts of the ISII to focus group members, as well as consulted my mentor professor with experience in middle school survey creation for input on wording, clarity, and content. After editing, a final sixteen item version was used in the next stage of the study. More information about the ISII is available in the following survey measures section and a full version of the inventory is available in Appendix D.

Stage 3: Quantitative Analyses.

Research questions. The two research questions for this stage were: 1) What are the socialization factors identified by young adolescent Latinas? and 2) How are these factors related to science outcomes associated with a science identity?

Procedure and study sites. After attaining university IRB approval, I contacted four local districts by email and followed-up with phone calls in the spring of 2013. One district agreed to allow data collection. Round Rock Independent School District (RRISD) is a suburban school district crossing two counties and governs schools located in the suburb of Round Rock, part of the suburb of Cedar Park, and portions of northern Austin. The district contains approximately 46,000 students and is 44% White, 30% Latino, 12% Asian/Pacific Islander, and 9% African American. There are 52 campuses across the district, including ten middle schools that cover sixth through eighth grades. According to the Texas Education Agency (TEA) website, 29.8% of students in the district are classified as economically disadvantaged and the high school dropout rate is 0.9%.

At RRISD, I contacted principals at eight schools with Latino populations over 25% as reported on the school district website and received permission at three schools to collect data. Principals, working with their teachers, gave permission to collect data from some grades or all of their students. In order not to single-out Latinas, I collected data from all accessible populations, but only include information provided by self-identified Latinas in this analysis. At School 1, with a Latino population of 25%, I delivered surveys to the school for distribution to one sixth-grade cohort of approximately 120 students. I had six surveys returned, with only one self-identified Latina student. At School 2, with a Latino population of 29%, I delivered surveys to be given by the science department to the entire school population of approximately 950 students. I had 197 surveys returned, including 38 Latina students. At School 3, with a Latino population of 41%, I delivered 250 surveys to be given to the sixth grade class. I had 33 surveys returned, including ten Latina students. The number of returned surveys reported here includes only those with completed permission forms. Specific response rates are difficult to determine as all schools requested extra copies of the surveys. Student participation was entirely voluntary with no compensation.

As RRISD had jurisdiction over the city of Round Rock and parts of Austin, participants from this district could live in either city and the largest participating school was actually located in north Austin. The Census Bureau (2014) reports that for those living near this school, the median annual income was $57,300 with 7.5% of the population under the federal poverty level (2014). Slightly less than 20% spoke a language other than English at home and 32.7% of the people over the age of 25 had a Bachelor's degree. Comparatively, for the city of Round Rock, the median annual income in 2012 was $70,000 with 8.4% of the population under the federal poverty level. A quarter of the population spoke a language other than English at home and 37% of people over the age of 25 had a Bachelor's degree.

In the fall, I contacted six more local districts and obtained permission to collect data at one district. Bastrop Independent School District (BISD) covers a semi-rural county approximately 30 miles south of Austin, with its largest metropolitan area the city of Bastrop, population around 7,500. There are 14 total campuses with two middle schools that serve seventh and eighth grade students. The district reports the overall racial/ethnic composition of their 9500 students to be 35% White, 55% Latino, 6% African American, and 4% other races/ethnicities. The TEA website reports BISD's high school dropout rate for 2011-2012 as 1.2% and 67.9% of students in the district were classified as economically disadvantaged.

According to the US Census Bureau (2014), the city of Bastrop had a median annual income over $51,800 with 6.6% of its population living under the poverty level, while Bastrop County had a median income of $52,500 with 14.1% living under the poverty level. In the city, 11.7% of the population spoke a language other than English at home while this number rises to 24.5% county-wide. Additionally, 20.2% of people over the age of 25 who lived in the city boundaries had a Bachelor's degree, while only 16.5% of those across the county have a college degree.

At BISD, I contacted the principals at the only two middle schools in the district, both with reported Latino populations over 40%, and I received permission to collect data at one school. I collected data from the entire school population, but only include Latina students in this analysis. A total of 700 surveys were given to the school and 218 complete surveys with permission forms were returned, including responses from 41 Latina students.

At the request of RRISD to minimize teacher workload, survey packets were distributed to students to take home and complete. Survey packets included the stapled survey along with two copies each of the parent consent form and the student assent form. A Spanish version of the survey was offered to schools, but was never requested by principals or teachers. All parent consent forms, however, were double-sided with English and Spanish language versions.

The survey packets were handed out in a manila envelope with a short explanatory letter about the study in English stapled to the front. The manila envelopes were sent home with students to obtain parent permission and complete at home. I estimate that surveys took about 30 to 45 minutes to complete. Parents and students were asked to sign one copy of the permission forms and return them to school with the surveys; the second copy of the forms was for their records. Student responses were only included in analysis if permission forms were returned with the survey. Teachers collected the envelopes at school and returned all packets to the researcher within a month. Teachers also received a small gift worth approximately $10 to thank them for their time in distributing the surveys. Survey administration took place in the Spring of 2013 for RRISD and in the Fall of 2013for BISD. (See Appendix D for the complete survey).

Participants. A total of 90 middle school Latinas participated in the survey collection with 49 students from RRISD and 41 students from BISD. Surveys were identified as coming from Latinas based on answers to an open-ended ethnic identity question and a forced-choice gender question. Forty-eight students reported their ethnic identity as Latina or Hispanic, without a more specific country of descent. Twenty-six participants specified their identity as Mexican American, two as Mexican, and one student identified as Mexican and Puerto Rican. Thirteen of the 90 students claimed multi-ethnic identities that included Latina. More specifically, the multi-ethnic students including two who identified as Asian and Hispanic, one who identified as African American and Hispanic, one who identified as Black and Mexican, five who identified as White and Hispanic, one who identified as Mexican American and White, one who identified as Hispanic, African American, and Puerto Rican, one who identified as Hispanic, American Indian, and Mexican American, and one who identified as Hispanic, Black, Mexican American, and White. Overall, 18% of the students were sixth graders, 35% were seventh graders, and 46% were eighth graders. All of the sixth graders were from RRISD.

The overwhelming majority of participants were born in the US with only two stating Mexico as their birth country. Additionally, of those who reported the information, 61% had both parents born in the US with only 39% having at least one parent born in another country. Fifty-eight percent of participants spoke English as their first language, 29% spoke Spanish, and 13% learned both English and Spanish at the same time.

On a self-report scale of socio-economic status, the range was from two to ten, with a mode of seven, indicating that most students felt their situation to be slightly better than average. Forty percent of participants reported that at least one parent had a career in computers, engineering, or technology. For the sample, the average reported science grade was 87% (SD = 8.02), average math grade was 83% (SD = 9.75), and average English grade was 85% (SD = 7.03).

Preliminary t-tests and chi-square analysis revealed no differences in these demographic conditions by district, with one exception. Students in BISD were more likely to report learning Spanish as their first language and less likely to report learning English as their first language , $\chi^2(2, N = 90) = 7.42$, $p = .024$. Students in both districts gave a self-reported socio-economic ranking of 7 out of 10, with the average for RRISD to be slightly lower, but not statistically different from BISD ($M = 6.64$, $SD = 1.74$ versus $M = 6.80$, $SD = 1.51$).

Survey measures. Survey measures and items were chosen in two ways. Measures either corresponded to an affinity as described above in the Mixed Methods section and therefore was necessary to evaluate the research questions. Other measures and demographic items were included because they assessed a factor previously identified in the literature as important and represented a potential confound to the study. As mentioned previously, Table 1 lists the scales and corresponding affinities and the full survey is available in Appendix D.

Demographic information. Demographic questions included on the survey obtained information on academic and career goals, first language, birthplace, generation status, parent education level, parent employment in healthcare, parent employment in science, engineering, or technology, self-reported socio-economic status, and racial/ethnic identity.

Grades. Math, science, and English grades were obtained from the districts. RRISD reported end of year grades. BISD reported the most recent six week grades from the Fall semester. I only include science grades in this analysis.

Science socialization experiences. Science identity socialization experiences were measured using the Influences on Science Identity Inventory (ISII) whose development was described above. The 16-item scale asked participants how often certain events occurred during their previous school years with five responses (*Never, Once or twice in my life, Once or twice a year, Once or twice a month,* and *More than twice a month*). Sample items include "Read science related books or magazines" and "Participated in science fairs and competitions." The full scale is listed in Appendix D. The alpha of the full scale for this study was .81. An exploratory factor analysis (described in the following chapter) identified three subscales: a college orientation subscale with an alpha of .80, a science career discussion subscale with an alpha of .88, and a science experiences subscale with an alpha of .76.

Science career interests. The Inventory of Children's Activities (Tracey & Ward, 1998) was used tin this study to assess the career planning outcome affinity identified in the qualitative stage. The inventory assesses general interest in activities that relate to broad occupational categories. Based on the RAISEC (Realistic, Investigative, Artistic, Social, Enterprising, and Conventional) categorization of career interests, the measure uses lists of school- and home-based activities as prompts for each interest area. Participants are asked to respond how much they like each activity based on a 5-point scale (1 = *don't like at all* to 5 = *like a lot*.) The realistic and investigative subscales with 5-prompts each were used as these correspond to basic interests in STEM careers. Tracey and Ward (1998) reported an alpha reliability of .79 for the realistic scale with middle-school students and a 1-week reliability of .71. The investigative scale had a .73 alpha coefficient with the same sample and a 1-week reliability of .73. The alpha reliability in this study was .86 for the realistic subscale and .78 for the investigative subscale. In a later study, Tracey (2002) found a one year reliability for the investigative and realistic subscales of .77 and .76 with middle school students.

Science attitudes. The Modified Attitudes toward Science Inventory (mATSI; Weinburgh & Steele, 2000) was also administered to measure more general science-related attitudes. Three subscales of five items each were used, including anxiety toward science, value of science, and desire to do science. Designed for urban, upper-elementary students, the scale uses a 5-point scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Sample items include "I feel tense when someone talks to me about science" and "Science is one of my favorite subjects." With a predominantly urban, African American population, Weinburgh and Steele reported an alpha of .70. The alpha for this study was .89 overall with .85 for the anxiety subscale, .74 for the value of science subscale, and .85 for the desire to do science subscale. Buck and colleagues also used the mATSI in a mixed methods study of science interests in middle school African American girls and found alphas of .84 for desire to do science and .87 for both value of science and anxiety (2009). This study also provided content validity for the scale as differences on scale scores were reflected in different experiences and attitudes of interview participants. The anxiety subscale and the desire to do science subscale both reflect on the emotion affinity discussed by the qualitative participants.

Science self-efficacy. Participants' self-efficacy in science was assessed with the Math/Science Self-Efficacy Scale, science subscale (MSSES; Fouad & Smith, 1997), as was used in Navarro et al. (2007). This 6-item subscale devised for middle-school students asked participants to rate their ability to succeed in science-related school-based activities on a 5-point scale (1 = *very low ability* to 5 = *very high ability*). Sample items include "Earn an A in science" and "Design and describe a scientific experiment that you want to do." Studies by Fouad and Smith (1997) assert the concurrent validity of the measure as it was able to detect changes in self-efficacy following an intervention, in addition to predicting related expectations, interests, and intentions. Previous studies with predominately Latino middle-school samples have reported Cronbach's alpha of .84 to .86 (Fouad & Smith, 1996; Fouad & Smith, 1997; Navarro et al., 2007). The alpha for this study was .67

Science self-efficacy was also assessed using the Patterns of Adaptive Learning Scales (PALS)—Academic efficacy subscale (Midgley et al., 2000) modified to address science class work. This five-item measure used a five-point Likert scale from 1 (*not at all true*) to 5 (*very true*). Sample items include "Even if the science work is hard, I can learn it" and "I am certain I can master the skills taught in science class this year." The alpha was .91 for this study. In a 2009 psychometric assessment of the PALS with college students, Muis, Winne, and Edwards found good reliability estimates and model fit during confirmatory factor analysis. Both measures overlap with the using your brain affinity identified in Stage 1 in which students discussed their interests in intellectually challenging subject areas.

Gender stereotypes. Gender stereotypes about girls in science were assessed with a stereotype endorsement measure created by Schmader, Johns, and Barquissau (2004). This three-item measure used a six-point Likert scale from 1 (*strongly disagree*) to 6 (*strongly agree*) with one item reverse coded. The authors reported a .88 alpha with a college student sample. For this study with adolescents, I changed the item wording from "men" to "boys" and from "women" to "girls". A sample item is, "It is possible that boys have more science ability than girls." The alpha for this study was .81. In a study of changing stereotypes with college math students, Ramsey and Sekaquaptewa (2011) reported reliability alphas of .87 for the initial data collection, although the secondary collection at the end of a semester, fell to .71. This measure was included because Flores and O'Brien (2002) found feminist attitudes to influence non-traditional career interests of Mexican American adolescent girls.

It should be noted that I originally intended to include a measure of gender centrality with a scale corresponding to the scale described below for ethnic identity centrality. However, the gender centrality measure was changed to a measure of gender stereotypes at the request of RRISD and after IRB approval. The district board felt that for most middle school students, their gender identity is salient at all times and that the measure would not provide enough variability in responses to be useful.

Ethnic identity centrality. Ethnic identity centrality was measured with the centrality subscale from three-part Cameron's social identity model (2004). This measure was also included as previous literature has found relations between ethnic identity and career planning (Gushue & Whitson, 2006). This four-item measure used a six-point Likert scale from 1 (*strongly disagree*) to 6 (*strongly agree*) with two of the items reverse coded. Sample items include "I often think about being a member of my ethnic group" and "The fact that I am a member of my ethnic group rarely enters my mind." Zhang and Noels reported an alpha of .71 for the centrality subscale on a study of ethnic identity of first and second generation Canadian college students (2013). The alpha was a low .58 for this study. As this alpha is significantly below the accepted threshold of .70, the scale was not included in subsequent analyzes.

Perceived social support. The Child and Adolescent Social Support Scale (CASSS-Level 2) developed by Malecki, Demaray, Elliott, and Norton (1999) was used to assess perceived social support. In this instrument, the authors conceptualize support as containing four dimensions: emotional, instrumental, informational, and appraisal. Twelve items apiece measure support from parents, teachers, classmates, close friends, and school staff for a total of 60 items using a six-point Likert scale for frequency ranging from 1 (*never*) to 6 (*always*). Sample items include "My teacher cares about me," and "My parent(s) take time to help me decide things." Malecki and Demaray (2002) in a psychometric assessment of the scale report coefficient alphas above .89 for all the subscales with middle and high school students, as well as strong factor loadings for the hypothesized five-factor solution. An eight-week test-retest correlation for the entire scale was .70 and ranged from.60 to .76 for the subscales.

In this study, the teacher subscale was modified to ask specifically about science teachers. The overall alpha was .97 with an alpha of .95 for the parent subscale, .94 for the science teacher subscale, .95 for the close friend subscale, .93 for the classmate subscale, and .97 for the school staff subscale. This measure was included because of its relation to the affinities of home environment, teacher influences, school experiences, and environmental factors.

Chapter 4: Results

Stage 1: Qualitative Results

The qualitative component of this study investigated two research questions: 1) What socialization factors contribute to the development of science identities in Latina adolescents? and 2) How do these factors relate to each other? To address the first research question, IQA focus groups of Latinas in science majors established common factors, or *affinities*. To address the second research question, I used results of interviews to construct a concept map of the relations between these affinities. In this section, I will first present a description of the eight common affinities and then will present the concept map with a detailed description of the system.

Affinities. The final affinity list has eight factors: *Home environment, Teacher influences, School experiences, Environmental factors, Media influences, Using your brain, Emotions,* and *Career planning.*

Home environment. The home environment describes how participants' family and close friends created an environment orientated toward academics. Participants discussed parents as role models, specific occupations of family members, and general support for academics.

For some students, parents acted as role models for a career in STEM. For these students, parents had explicit positions as role models for future careers. One student talked about her father. "Well, I want to be a dentist now, and he's a dentist, so he kind of inspired me to follow his route. He was supportive of when I wanted to be a doctor before, but now when I've seen their lifestyle, I like the profession of dentistry." For another student, watching her mother return to school to pursue a degree in speech therapy also acted as a model for her, leading her to pursue the same degree. "Yeah, that's what I'm pursuing right now, speech therapy... My mom went back to school when I was like 13. I saw that whole process as well, so that kind of influenced me."

The specific parental role model was often mentioned with health care professions, although there was some variability. For example, two students who were pursuing medicine had fathers in engineering, but both discussed the emphasis on math and science in their homes.

Parents were not the only family members with important effects on students' STEM identities. Other family members, often siblings, played an important role in the lives of these young women, again often acting as role models for academic achievement or STEM careers specifically.

> My brother is the first one to go, he's the first one to graduate college from our family. So when he was in the process of applying to school and I was like what are you going to major in and he was like "I'm going to be an engineer" and I asked "What's an engineer?" We would look up what engineers would do and all these things and just that he went into STEM influenced me, maybe not engineering, but in the sciences.

Another student recounted the effect of visiting her older brother away at college. "I didn't know what college was at first. After that, I already knew, it's elementary school, middle school, high school, then college. I didn't question going to college. It was like, they did, so now I have to do it too."

Not all students had family members in college or STEM-related careers to act as role models. In these cases, parents were often still noted as important for creating an academically orientated atmosphere. Parents appeared to do this in two major ways: first, parents verbally shared with children their high expectations and second, parents provided opportunities to encourage academic thinking.

In terms of high expectations, parents with less material means often appear to frame this as wanting more for their children. The women in focus groups and interviews often would talk in about these expectations in second person voice, repeating what had been said repeatedly to them. "Growing up my mother always raised me, 'You need to excel in high school, you need to do well, only get A's, you have to go to college. We are in a world now where if you don't go to college, you're not going to succeed and I want more for you than what I had.'"

Parents also created academically orientated atmospheres by providing academically orientated materials and experiences for their children. Many students mentioned going to libraries, science museums and zoos with their families. Others mentioned receiving science-related toys, like microscopes, although even non-science toys could be appropriated for science play. "Since I was a little girl, they would buy me Barbies. I really liked the nurse Barbies. But what I would do to my Barbies is rip them apart and then pretend I was a doctor and tape them up." One student discussed how a new family computer was used to encourage her science interest.

> For some reason, my parents bought a computer, you know a big, massive computer. And so we had internet and I was able to search plants and stuff and I don't know why I was so addicted to learning every little fact about plants. And I would write it all down. I wanted to be a plant biologist at ten.

While parents were often positive influences on STEM identities, students were aware of how parents could either push too hard or not enough.

> One of my friends, she said that she really wanted to be an engineer, she always told me that. I would tell her to go for it, but she was like, 'Well, my mom and my family doesn't really care.' Well, I was like, don't do it for them, do it for you. You'll be able to help them more in the long run. I know my parents were like, go to school, get in debt, who cares? Just go for it. And like her parents were like, how you going to pay for it? How you going to do it? Just not having that support at home.

Another student recounted how her father was always encouraging her to become a doctor, but when she went into engineering in college, he became upset and did not speak to her for a time. Another student talked about being teased for wanting to be a veterinarian.

Teacher influences. This factor reflects how particular teachers played a role in developing a subject interest. When asked about influences on their science interest, many students named a particular favorite teacher. Drawing out students on the subject, characteristics of influential teachers included subject knowledge, high expectations, and enthusiasm. Teachers who talked about the career implications of STEM knowledge were also cited as influential.

Most students characterized good teachers, first, as knowledgeable and experienced in their subjects. One student saw her biology teacher's ability to engage in discussion about the material as important to her own developing science identity. "She guided me to choosing a career in biology because she was one of the few people that actually allowed me to be more engaged in the subject and whenever I had questions she would always help me out and she provided a lot of insight into biology." Another student also discussed her high school biology teacher in similar terms. "You could tell she knew the material so well and was so excited about it. I remember doing dissections and stuff and she was just so relaxed about it. So she was kind of my inspiration and I loved the subject."

Many of the teachers were characterized as "strict", often in reference to the expectations for classroom conduct. "He was a very straight person. He used to be in the army, very strict, but I loved him because he did math ladder and I always won." Another student also discussed a favorite teacher this way. "I remember that she was stricter, like the first strict teacher we had. You know, going from elementary to middle school and I kind of liked that."

Teachers who were enthusiastic and approachable were also highly appreciated by the students. One student mentioned a young, Teach for America chemistry teacher.

> She was so passionate about science, she was like, 'You guys can do whatever you want.' She introduced me to how you extract DNA and that was the first time

> that I extracted DNA from coffee beans, and I was like, 'You can extract DNA from coffee beans?' and she was like, 'I'll teach you.' That was when I got interested in research.

Another student who changed schools in fourth grade, mentioned the science teacher at the new school as important because, "She was super nice and she just made it an easier transition, so I really liked her."

Finally, some teachers were mentioned as influential, because they discussed with students the opportunities available to those with STEM knowledge. One student mentioned a high school biology teacher. "I remember she was like, biology and the sciences are such great fields because they have a wide variety of things you can major in and you can make a career in it. It can accommodate specific interests." This student felt that the extra encouragement from her teacher helped her choose her college major.

School experiences. School experiences describe events that happened in a school's setting that had an impact on science interest. Some components of school experiences included interesting topics, hands-on engagement, academic competitions, and field trips.

Almost all students talked about engaging in hands-on projects throughout elementary, middle, and high school. Many students were able to recount details of projects from their earliest school years.

> In elementary school our teacher gave us lima beans and then we put a moist towel and we put the lima bean in the middle of the towel and we put it in a plastic bag. Then we started seeing the process of the plant growing without

having to plant it on soil. I thought that was the most amazing, the coolest thing ever. And then when I got home, I was like let me find all the beans and my mom was like, "What are you doing?" I was like, "I'm growing all these plants" and she was like, "No, no, no, no." But that was probably one of the first things that got me into biology.

Another student talked about the common microscope experiment with staining an onion root to observe mitosis. "We cut the root of the onion and put it on the slide and then we did staining and all that and we looked at the mitotic spindles and all that and I was like, 'Oh, my god it's growing.' I think that is what caught my attention, how something basically grows and continues to grow."

Starting in middle school, dissections were commonly mentioned by students, although others did not have the experience until high school anatomy and physiology class.

> Yeah, it was so odd being a little 12 year old dissecting a starfish when you've never even seen a live one. And it was so interesting. I've always been real squeamish when it comes to worms, but no one else wanted to dissect it. I was like, oh my god, you guys are so dumb. So I took charge and cut it open and held it open and everything. It was just…well it was a worm, and I'm kind of scared of them when they are alive, you know, so I felt better that it was dead. I don't know, it was just really fun to take charge and cut into something.

A common experience recounted by many of the women was taking a class that exposed them to personally interesting topics. For example, one student said, "My school, I hated biology with a passion. Well, I hated all science classes basically. Then I came into anatomy and physiology and it just interested me to so much. That's what really made me want to do some sort of science class." Another student talked about learning to balance chemical equations, "Once we put everything together and balanced all the equations, I found that really interesting and to actually know what numbers to compare to actually balance the equations, our teacher helped us a lot with that. That was a good experience."

Competitions provided opportunities for students to engage in learning that was personally relevant while also providing feedback about their performance in relation to others. One student, reflecting on her first science fair in eighth grade said, "When I was going around looking at everyone's posters, I found it really awesome all these things you could do with science. There were so many different areas of science. I always knew plants and animals, but there is so much more and it was really cool." Another student who had experiences with science fairs in early elementary said, "I think maybe I was more interested in the pretty part of it, and like showing off, but I was learning too, so it kind of sparked science at the same time."

Field trips or other types of school-sponsored activities outside of the classroom were also mentioned by many students. Most often mentioned were field trips to science museums and nature centers. One student recounted,

> I don't remember if it was 3rd or 4th but I do remember going to the natural history museum and it just sparking an interest in general, kind of a wondering,

> based on the different exhibits. There was something about science that wasn't straightforward, but left me wondering, 'Ok, how does that work?'

Field trips to college campuses were also mentioned as very impactful for those who had the chance to experience them. One student talked about college visits with her high school class. "We went to about 20 different colleges, and every time we went, they were like here's our STEM programs, come here and do STEM. Because our school was mainly minority students, they were always focused on getting us into engineering and science on the college visits." Another student was selected to visit a prestigious west-coast university while in eighth grade.

> We got to go into the dorms and I got to talk to medical students and undergrads and they were real cool even though I was like a 12, 13 year old being annoying, asking questions. They let us tour the university and I thought these people look so cool. I wanted to be like them and I liked what they did. They would show us some experiments, basically anatomy and physiology based. They showed us how medical students get to open up the cadavers and I was like that is so cool.

In summary, schools provided opportunities for hands-on engagement with science either within their own walls or by providing outside resources that would not otherwise be available to these young women. One woman summed up the effect of being able to do science. "I feel like I learn more when I actually do stuff and have my hands on the experiment, when I'm performing the experiment, than when I'm observing. To me, I find it interesting you don't really know when you do an experiment what the outcome is going to be, so that was intriguing and I was curious. That helped me. It filled my curiosity."

Environmental factors. This affinity describes how personal situations or , environmental settings became associated with a STEM interest for participants. These were events and activities that happened outside of school and were also outside of the walls of the family home. For some students, impactful events, such as a relative's illness or participation in a sports event, contributed to their growing science identity. For other students, more contextual circumstances, such as childhood neighborhoods or immigration experiences, impacted their identity. The affinity holds some connection to Bronfrenbrenner's ecological systems theory and can be thought of as factors from the outer layers of the system that the participants themselves identified as impactful on their development. For the most part, these events and activities included some aspect of fate, or the belief that they were outside the control of either the participant or their immediate family. This factor remains the most individual for participants as its manifestation depended on the context of each person's childhood.

Childhood neighborhoods were the most commonly referenced category in this affinity. One participant was influenced by the eco-consciousness of her hometown.

> I would say growing up here, Austin has always had an emphasis on the environment. I grew up recycling. And the environment is one of the reasons I got into science in the first place. I took environmental science and part of that is biology. And then in college, ecology, and how humans work with all of that. So that is what really got me into science

Some students became more aware of the importance of their childhood environments after they moved. Students recounted changing schools as families moved to more affluent areas and that the process made them aware of differences in material support and opportunities provided by the schools.

> I remembered an elementary school friend and I used to go to like a bad area, and we [my family] moved to a better area. She was interested in science too and she would always say, "I want to be a doctor" and she ended up getting pregnant like two or three years ago and she's still in that same area. I guess it was the environment had a lot to do with it.

Moving across countries, or immigration experiences, also impacted students. One student, whose family had moved trans-nationally several times in her youth, knew that she would have to return the US from her father's home country if she wanted to achieve her dream of working for NASA and being an astronaut. Another student, who moved to the US at a young age, saw math as a way to rise above the language barrier. "When I moved here, I didn't speak English, so math was like the easiest thing for me to do. So, I started when I got to middle school, I started to take math classes and it was just easier, the work."

Participating in sports was another environmental factor, although this influence was limited to those who had an interest in medicine. One student who said sport participation was her biggest influence explained, "I've just been playing sports my entire life growing up. And once I started playing in high school and club teams, I would have to go see the doctors more often. So, I'm interested in med school." Another student, whose running injuries forced her to see a physical therapist, found that the visits inspired her to explore the career possibilities in the field.

A final area of environmental factors related to traumatic medical events or long-term illnesses. Those with an interest in medicine almost exclusively mentioned this area. For example, a student whose grandfather had Alzheimer's disease discussed how the diagnosis led to her interest in medicine.

> I wanted to be informed about what was going on. I think that helped me a little bit to put my focus on biology and what could I do in the future that could look at disease…You learn about all the mechanisms, and for him with Alzheimer's, the brain and everything. So it helped me know what was going on and it helped me cope, to know what might happen in the future.

Another student described how accompanying a sick grandmother to the hospital to act as a translator was important for her own interest in medicine.

> I was probably like 11 or 12 and … I would go with her to her office visits and I would see everything and that's when I started researching cancer and why this happens and everything. I was never at a hospital myself because I was sick. It was always because I was translating for my family members. So being in that environment, I wanted to do this and help others, so that is what really motivated me. That is the greatest thing that motivated me.

While illnesses in family members was the most commonly cited, other students mentioned as impactful the illnesses of childhood friends, neighbors, and pets.

Media. This affinity refers to how different forms of media influenced an interest in STEM. Media discussed included TV shows, books, and websites. Students frequently mentioned watching science shows geared toward children, specifically *The Magic School Bus* and *Bill Nye the Science Guy*. One student, who was responsible for watching her younger siblings afterschool, said, "We would just sit there and watch PBS. And I remember Bill Nye just being crazy and dropping things off buildings and blowing stuff up. I thought that was so cool." Two students also specifically recalled being able to watch *The Magic School Bus* in Spanish as young children. "Yeah, I was watching it and I didn't know it was science, I just thought it was fun. We didn't know we were learning, but we were. It was cool."

Watching TV was a family activity for many students, Real-life surgery shows, medical mystery stories, and the technology show, Mythbusters, were most commonly mentioned. Several women specifically mentioning watching non-fiction shows with their fathers as a bonding experience.

> When I was younger, my mom would work during the day and my dad would work at night, so I would have him during the day and because, I guess, it's kind of hard for fathers to bond with their young daughters, I remember he would watch a lot of Discovery Channel and things like that. He wasn't an educated man, but he really liked weird stuff like watching surgeries on television and things like that. I'm not interested in becoming a doctor or anything, but the whole mad scientist thing about it, seeing a doctor drop a heart on the floor, or just horrible things that can go wrong. It was so cool.

Students currently interested in medicine were also likely to mention one of the several popular medical dramas on TV as inspirational. *Gray's Anatomy* was the most commonly mentioned show, with other students also talking about *House*. Most students liked the narrative stories of the shows, but also saw the shows as models of life in the medical profession.

> I like the more dramatic shows, not the real science shows. I would just see how they kind of were doing science, although it was just TV science. That was still interesting too, and hearing how you want to be a doctor when you grow up because of the financial stability. And it was just interesting to see their lives in that way.

Websites were sparingly mentioned by students, and most often in relation to an already developed interest at an older age. One student whose family shares technical and engineering interests talked about the ThinkGeek website, a site that sells technology and internet-related toys and gadgets. "The website kind of explains us because we usually find products on there and talk about them. We'll buy things, each other gifts from there and we just really like that website. And, yeah, I think that's the influences on my life." Another student, whose current career plans is in computer information management, started learning about coding on MySpace.

> You had to know some HTML code to make your profile look pretty and add certain text to it and pictures and stuff. Looking back, I'm glad it worked the way it did because I feel like, without realizing I was coding, I was coding and it made it fun. Because I was like, I want this to look pretty, so this is what I have to do

> and you're googling code, trying to figure things out, copying and pasting, and that's how it works in the real world, you just kind of have to do it. So, I would say that was the biggest influence.

This affinity was the most troublesome for inclusion as a separate category, because while some participants felt the media was a significant contributor to their science identity development, others felt that the media had little to no influence on them. While not an exclusive line, this division was most visible when examining those in the life sciences versus physical science and engineering, with those in life sciences more often endorsing the importance of the media. This division is discussed more in the section on the concept map.

Using your brain. This affinity represents how participants viewed STEM as intellectually challenging as well as a reflection on their innate ability in the subject. This affinity is the closest representation to the concept of self-efficacy, an important component of career and interest development according to both social-cognitive theory and expectancy-value theory. While self-efficacy concerns a person's beliefs in his or her own abilities, this affinity includes an appreciation for the challenge that studying STEM involves. Students acknowledged that STEM classes involved hard work, but the work was intellectually satisfying and became an experience that they sought out.

Students usually realized they had a talent or ability in STEM through school experiences or through prompting from a teacher. An engineering major described winning a math contest in elementary school, "It gave me courage to be like, you know, I'm actually good." One student was encouraged by teachers to change from a regular class to a pre-AP class the first year in high school. "When I went into AP, I was still getting better grades than all the ones that had already been in AP. I remember on my report cards, getting 100's all across on my biology. I just felt like, wow, I'm good at this and I like it, so it just started becoming a passion." The positive feedback from these school experiences helped students build their beliefs in their abilities in STEM.

Additionally, for these participants who excelled in academics overall, the challenge of the work was as important as the belief in their ability. One student described her initially conflicting opinions about a third grade, car-building project. "I remember being creative and all was hard for me to do, but I still remember enjoying the topic of science." Another student discussed not really liking science until high school. "My 9th grade biology class was really hard. It was challenging and the teacher was kind of scary, but it felt really good, finally understanding everything. It was really interesting."

A common metaphor was to games or puzzles. Students felt that learning STEM was a challenge that allowed them to exercise their minds. A biology student commented, "I always thought it's kind of like a riddle or a puzzle to solve and you know when you get the answer, you're like, 'Yes, I got it.' So it's kind of like a game for me." An engineering student also described learning coding with similar language.

> I sit there and I fail and I fail. But then it clicks, then it happens, and then you succeed...I'm good at it, but at the same time it's still a problem, it's still something I had to figure out and I really enjoy that. It's a puzzle.

STEM areas offered cognitive complexity that students found to be a reason to engage with the subject.

Emotions. This affinity concerns the emotions generated from studying STEM, as well as the actual and anticipated emotional rewards for participating in STEM classes and careers. Students commonly described some aspect of science for them as "cool," "fun," "exciting," or "awesome." "Loving" an aspect of science was also a common phrase. For example, in a focus group, one student wrote a card that said, "5th grade science was FUN!" Another student described how much she enjoyed dissections in high school anatomy classes.

> Everyone was like, 'Eww, I don't want to do this.' And I was like, 'I love this.' Sometimes, I know this sounds gross, I would do it without gloves because I really wanted to touch and see how it felt. And everyone was like, 'Eww, that's gross.' I said, 'No, this is cool.'

Some students were aware that having these positive emotions toward science was unusual.

> Well, I really liked my chemistry labs. And everyone hated them because we had to write a lot afterwards, these ridiculous lab reports. But I really thought it was worth it. I thought it was so exciting when we did titrations [a laboratory method to determine chemical concentrations]. Everyone else just thought it was a waste of time, but I really enjoyed it.

Another student wrote on a card about remembering how high school chemistry and biology classes would make her smile. She added in discussion, "People thought I was a freak, because I liked it so much and everyone was falling asleep."

Career planning. Career planning describes how participants evaluated future career choices in STEM and how that played into their interest in the field. Participants saw STEM careers as good life choices because of the financial stability they offered. The importance of financial stability was often tied into previous discussions with parents to achieve and be self-supportive, as well as an interest in financially supporting elderly parents. Many students talked about family advice to become a doctor or a lawyer. One student said her family jokingly told her to "Do what makes the most money." Another student recounted her mother's advice. "All I want you to do is get good grades, go to college, get a good job, make lots of money, and get your momma a maid." The decision to enter a science major was often a practical decision, as well as emotional.

> I really, really love science and I really do believe biochemistry is something I want to do, but I'm afraid I'm doing it, because it's what I hate the least, you know, besides music…My dad went to college in Mexico, but I'm first generation here in the US. My mom didn't even get through high school, I think. And so, I think in their eyes, it would be a waste. It's not that they believe, or I believe, that people who study other subjects aren't successful, but they think about success in life as stability, economic stability, and they see that in science and medicine and such.

Many students mentioned the social good resulting from their chosen careers. A senior engineering student first learned about civil engineering from a guest lecture in a high school class.

> There was a civil engineer who came and talked about how many lives they could save by making buildings better. So I thought about all the lives I could make better. Like in Mexico, every time I go, it's very rural and every time I go, the roads are in dire need of a lot of improvement. So I remember thinking while a junior in high school, hey, I want to do something kind of like that.

A student majoring in environmental science saw her career goals as tied in with an awareness of the context of development. "I want to help other people realize how we can be like economical too, because like some of my family over there [San Antonio] live in the barrio and can't afford organic food and stuff like that, so I want to like help people realize that it can be beneficial too."

There was also an aspect of obligation to pursuing a career in science, given that these young women had academically excelled in the subject. A biochemistry major wrote a card in focus group that said, "When I spoke about other possible professions while growing up, the one phrase my family always said to me was: but you are so smart; you'd be wasting your brain." Another woman spoke of this obligation in more positive terms. "And to actually have a passion for this [science], being Latina, and a woman, it's a gift, you know. You gotta do it."

Concept maps. After establishing the affinities, the next step in IQA is to look at possible directional relations between the affinities. Table 2 lists all the relations that were endorsed by the 12 interviewees and the two focus group members who responded to follow-up emails. The most commonly endorsed relations (n = 12) were from *home environment* to *career planning* and from *teacher influences* to *using your brain*. Eleven participants also endorsed relations from *teacher influences* to *school experiences* and from *emotions* to *career planning*. No participant endorsed relations from *school experiences* to *teacher influences* and from *media influences* to *teacher influences*. All other possible relations received at least one endorsement.

Table 2
List of all possible relations between affinities and the number of times participants endorsed that relation. Arrows indicate the direction of the relation as seen by the participant. (N = 14).

Affinity pair relationship	Frequency nominated	Cumulative frequency	Cumulative percentage
Home environment > Career planning	12	12	4.36
Teacher influence > Using your brain	12	24	8.73
Teacher influence > School experiences	11	35	12.73
Emotions > Career planning	11	46	16.73
Home environment > Emotions	10	56	20.36
School experiences > Career planning	10	66	24.00
Using your brain > Career planning	9	75	27.27
Media influences > Career planning	8	83	30.18
Home environment > Using your brain	8	91	33.09
School experiences > Using your brain	8	99	36.00
Environmental factors > Emotions	8	107	38.91
School experiences > Media influences	8	115	41.82
Teacher influence > Career planning	8	123	44.73
Home environment > School experiences	7	130	47.27
Media influences > Using your brain	7	137	49.82
Environmental factors > Career planning	7	144	52.36
Home environment > Environmental factors	7	151	54.91
School experiences < Environmental factors	7	158	57.45
School experiences > Emotions	6	164	59.64
Media influences > Emotions	6	170	61.82
Teacher influence > Emotions	6	176	64.00
Environmental factors > Using your brain	6	182	66.18
Home environment > Media influences	6	188	68.36

Table 2 continued

Affinity pair relationship	Frequency nominated	Cumulative frequency	Cumulative percentage
Teacher influence > Media influences	6	194	70.55
Home environment < Media influences	5	199	72.36
Using your brain > Emotions	5	204	74.18
Home environment > Teacher influence	5	209	76.00
Environmental factors < Using your brain	4	213	77.45
School experiences < Career planning	4	217	78.91
School experiences < Using your brain	4	221	80.36
Home environment < Environmental factors	4	225	81.82
School experiences < Emotions	4	229	83.27
Using your brain < Career planning	3	232	84.36
Teacher influence < Career planning	3	235	85.45
Media influences < Emotions	3	238	86.55
Media influences < Career planning	3	241	87.64
Home environment < Using your brain	3	244	88.73
Teacher influence > Environmental factors	3	247	89.82
Home environment < Emotions	2	249	90.55
School experiences < Media influences	2	251	91.27
Home environment < Career planning	2	253	92.00
Emotions < Career planning	2	255	92.73
Teacher influence < Emotions	2	257	93.45
Home environment < School experiences	2	259	94.18
Environmental factors > Media influences	2	261	94.91
Environmental factors < Media influences	2	263	95.64
Environmental factors < Career planning	2	265	96.36
Media influences < Using your brain	2	267	97.09
Environmental factors < Emotions	2	269	97.82
Home environment < Teacher influence	2	271	98.55
Teacher influence < Using your brain	1	272	98.91
Using your brain < Emotions	1	273	99.27
School experiences > Environmental factors	1	274	99.64
Teacher influence < Environmental factors	1	275	100.00
Teacher influence < School experiences	0	275	100.00
Teacher influence < Media influences	0	275	100.00

After tallying endorsed relations, I ranked the affinities in order of the number of relations endorsed coming both to and from the affinity to determine the drivers and outcomes of the system. In this case, *home environment* and *teacher influences* are both considered primary drivers because overall participants saw these factors as being the precursors, not the outcomes, in relations. *Outside factors* and *school experiences* were both secondary drivers. They had more outgoing relations than incoming relations. *Media* was neutral with equal numbers of outgoing and incoming relations. *Using your brain* and *emotions* were secondary outcomes and *career planning* was the lone primary outcome.

At this point, I drew three preliminary concept maps, or cluttered SIDs, representing systems with relations endorsed by five, six, or seven or more participants. The final concept map included relations that had been endorsed by six or more of the 14 participants. This map includes 70.5% of all endorsed relations and included no ties or conflicts. This map was chosen because it offered the most interpretable arrangement of affinities that best reflected the stories of the women from the focus groups and interviews. Figure 3 shows the cluttered SID and Figure 4 shows the clean SID, or final concept map.

In the clean SID, or concept map, the first affinity is *home environment* and it directly links to *outside factors.* Parents were normally talked about in *home environment* and they were seen as having a direct influence on the contextual experiences of participants. For example, parents decided which school students attended and parent jobs were the cause of immigration to the US.

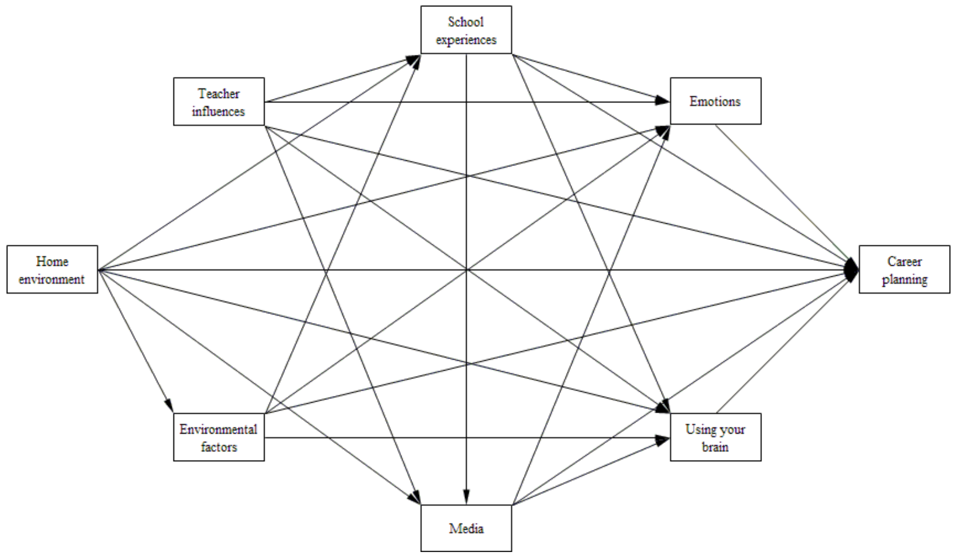

Figure 3. Cluttered systems influence diagram (SID) for all participants (N = 14). The direction of arrows indicate the direction of influence endorsed by at least six of the 14 respondents.

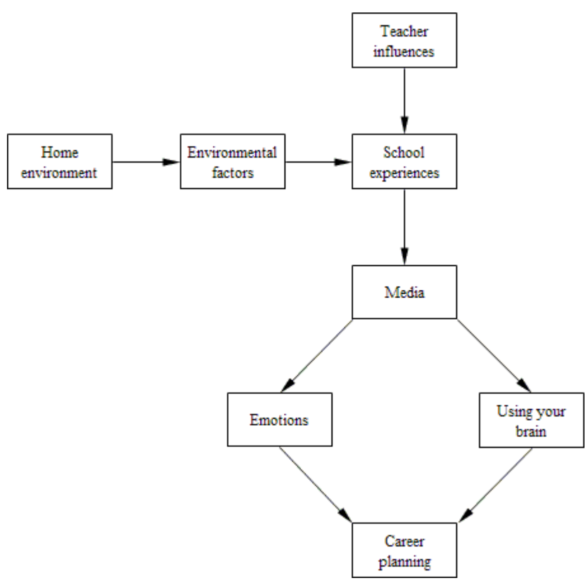

Figure 4. Clean system influences diagram (SID) for all respondents (N = 14).

Teacher influence was the other primary driver and it, along with *outside factors,* influenced *school experiences.* Teachers, as leads in the classroom, were seen as important in determining exposure to subject matter and chances to have hands-on learning. *Outside factors* were seen to influence *school experiences* because students were aware that contextual factors like neighborhood situation influenced the quality of their education.

School experiences were linked to *media*. Some students recounted being inspired by a particular school experiment or subject to seek out TV shows or websites about the subject. However, the placement of *media* here is slightly problematic as some students did not feel as if the media was important to their story. This is discussed more later.

Following *school experiences* and *media,* are the affinities of *using your brain* and *emotions*. Many students felt that what they learned in school gave them positive feedback about their abilities in STEM and that they also appreciated the challenge presented by these school subjects. *School experiences* were also influential on emotions, with many students talking about their experiences in terms of "fun," "love," or "passion."

Finally, both *using your brain* and *emotions* were direct influences on the *career planning* for these participants. STEM careers are viewed by students as opportunities to use their talents while engaging in something fun. Career planning included practical concerns for these students, many of whom grew up in less affluent areas.

Of the 14 participants in this phase of the study, eight had majors or career goals in the natural sciences or medicine and six had majors or career goals in the physical sciences, engineering, or technology fields. I decided to create separate concept maps for each group for two reasons. First, researchers continue to document gender disparities between the natural and physical sciences. Second, two of the six physical science/engineering/technology majors did not consider the *media* affinity to have any relevance to their science identity, with the other four endorsing the *media* at low levels, indicating that this affinity may not be important for this group of students.

The cluttered SID and the clean SID for those in natural science/medicine are shown in Figures 5 and 6, respectively. At least four of the eight participants endorsed the relations shown in the cluttered SID and the map includes 61.6% of all endorsed relations. The clean SID is almost exactly the same as the one for all participants (Figure 5) except for the placement of *media*. In this case, *media* is a primary driver, influencing the *home environment*. For some students, this link appears to result from the relation between watching TV shows with family members. Others appear to endorse the idea that people in the home use the media to generate ideas about appropriate careers and encourage their children in that direction.

Figures 7 and 8 show the cluttered SID and the clean SID for the physical science/engineering/technology majors. At least three of the six participants endorsed the relations shown in the cluttered SID and the map includes 65.3% of all endorsed relations. In this diagram, the placement of *emotions* has changed from an outcome of *school experiences* to the driver of *school experiences*. For these women, rather than emotions resulting from school events, they see themselves as more active in the process, using their emotions to guide what school experiences they seek out. *Media*'s placement has also changed in this diagram. While school experiences still drive what media is sought out by students, *media* no longer has a direct effect on any of the outcomes.

Looking at all three diagrams overall, there are some commonalities. H*ome environment* always influences *outside factors*, *using your brain* always influences *career planning*, and *school experiences* are a central affinity. *Emotions* and *media* vary in their placement within the system. *Emotions* changes from driver to outcome, but stays within the middle of the system and keeps a link with *school experience.* The direction of the relation with *school experiences*, however, seems to be variable. *Media* has the most variability, presenting as a primary driver, a neutral link, or a secondary outcome

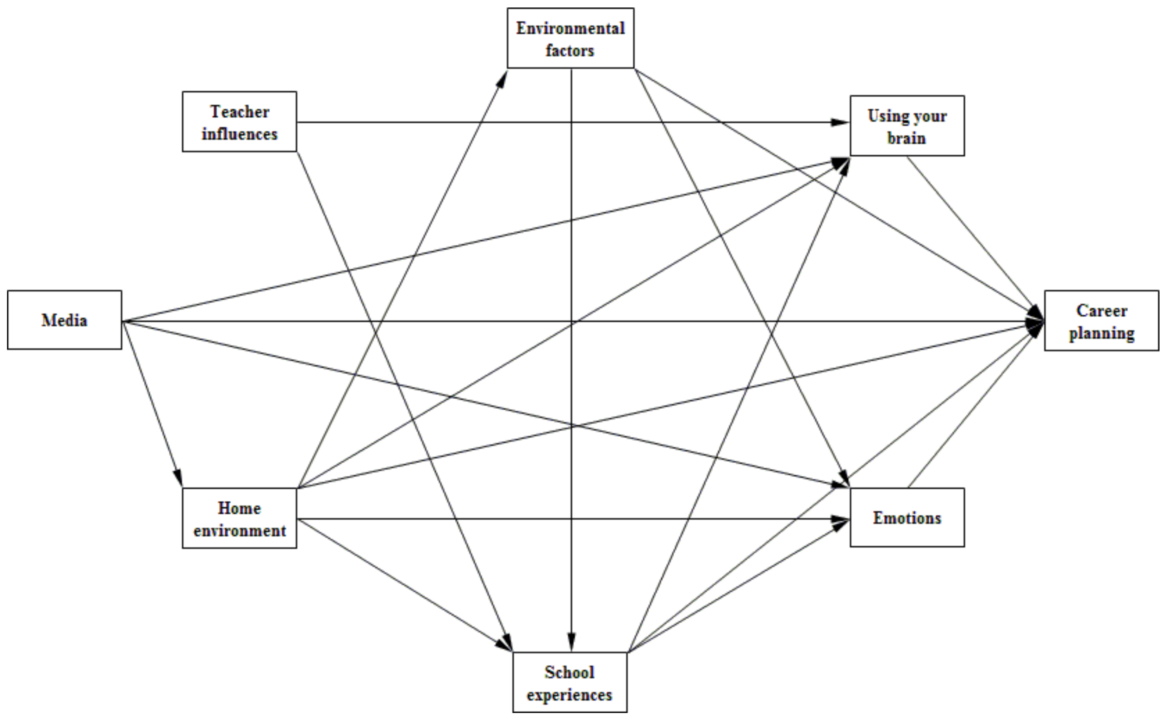

Figure 5. Cluttered SID for natural science/medicine majors (N = 8).

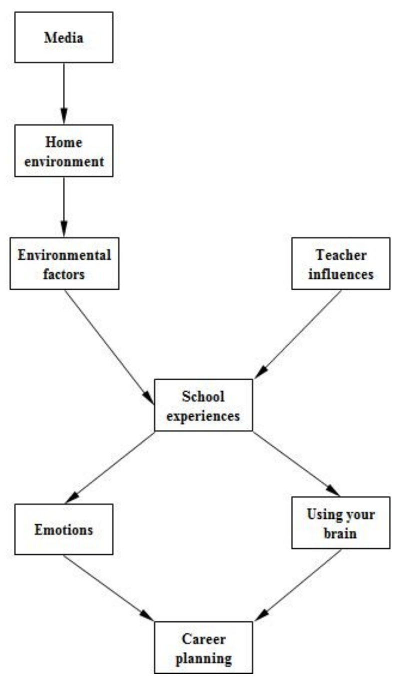

Figure 6. Clean SID for natural science/medicine majors (N = 8).

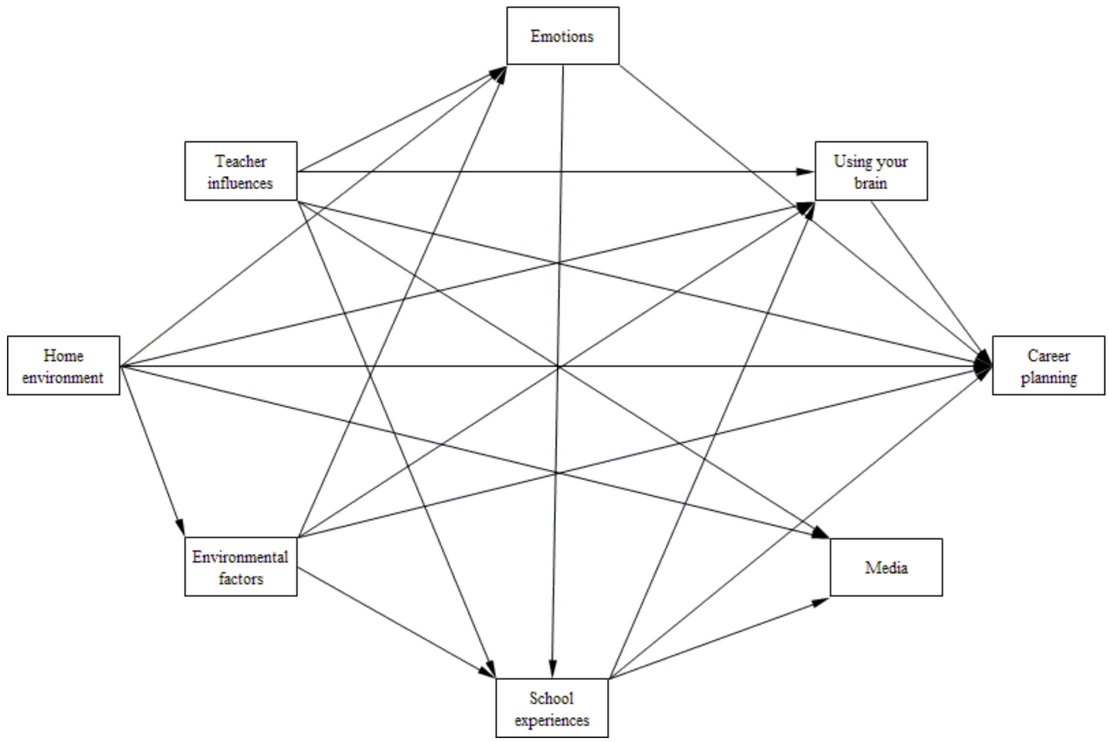

Figure 7. Cluttered SID for physical science/engineering/technology majors (N = 6).

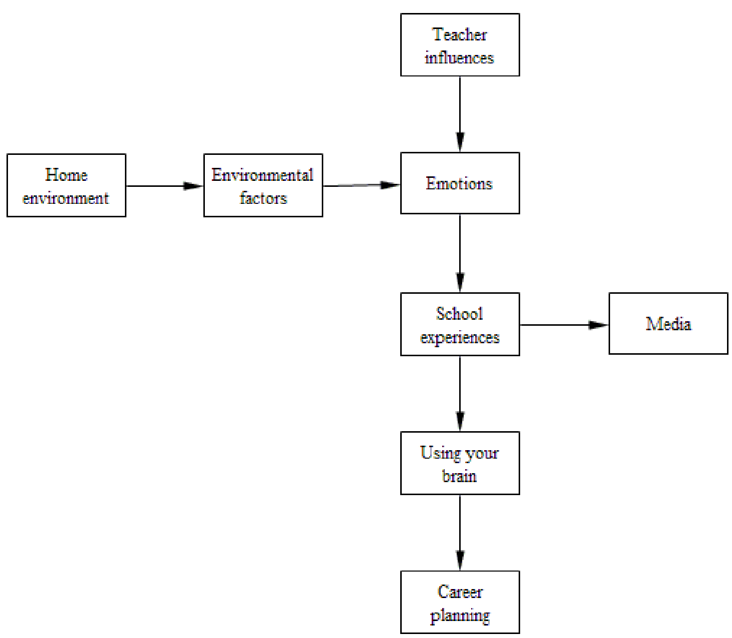

Figure 8. Clean SID for physical science/engineering/technology majors (N = 6).

Stage3: Quantitative Results

Research Question 1: What are the socialization factors identified by young adolescent Latinas?

To examine this question, I used a two-stage progression. First, I examined individual items on the ISII in terms of their overall endorsement and their relations to demographic factors. Next, as the first step in constructing a measure on science socialization practices, I used exploratory factor analysis to determine if the items on the ISII could be collapsed into a meaningful groups of items, or subscales. This exploratory analysis is the first step in the process of creating a validated and reliable scale that will extend over several future studies. While keeping their exploratory nature in mind, however, subscales derived from the ISII were then used in subsequent analysis to investigate Research Question 2.

ISII item frequencies. To answer the first question about types of socialization experiences, I first generated descriptive data from the ISII survey created from the qualitative data collection. The ISII is an inventory designed to measure how often particular events occur in a population. Items were measured on an ordinal scale and consequently the data on items is discussed in terms of distributions and modes, rather than means.

Results from the ISII show that young Latina adolescents are experiencing different science socialization experiences to various degrees. See Table 3 for distributions of responses to all items on the ISII. The most highly endorsed item was talking to family about college in general, with 42% of these young women discussing college with family members once or twice a month. The mode for similar discussions with friends and teachers, however, was only once or twice a year. The next most endorsed items were participating in hands-on activities in science class and playing outside in nature, with over half the sample reporting these activities at least once a month. Students also reported watching science-themed TV shows once or twice a month. A little over half the sample also visited science-related museums at least once or twice a year.

Three of the four lowest items with a mode corresponding to “never” were talking to others about a career in science, indicating that about half of the sample had never talked with family, friends, or teachers about a career in science. The other low scoring item was playing with science-related toys, with over three-quarters of the sample saying they had played with these toys twice in their lives at most. Additionally, low numbers of students reported visiting a college campus, reading science books or magazines, and participating in science fairs, with the mode for these items at once or twice in their lives.

Table 3

Responses to Influences on Science Identity Inventory (ISII). The survey prompt was, "Please mark how often you experienced the following in elementary and middle schools."

	Never (0)		Once or twice in my life		Once or twice a year		Once or twice a month		More than twice a month		Total n
	n	%	n	%	n	%	n	%	n	%	
1. Read science related books or magazines	12	13.3	**30**	**33.3**	27	30.0	17	18.9	4	4.4	90
2. Watched science related TV shows	8	9.1	21	23.9	17	19.3	**28**	**31.8**	14	15.9	88
3. Played with science-related toys at home (microscopes, chemistry sets, telescopes, etc.)	**43**	**47.8**	27	30.0	10	11.1	6	6.7	4	4.4	90
4. Played outside in nature (collecting bugs, watching animals, identifying plants, looking at stars, etc.)	5	5.6	13	14.4	15	16.7	18	20.0	**39**	**43.3**	90
5. Visited museums with science exhibits or activities	9	10.0	35	38.9	**39**	**43.3**	5	5.6	2	2.2	90
6. Participated in hands-on activities in science class	2	2.2	8	8.9	22	24.4	27	30.0	**31**	**34.4**	90
7. Participated in science fairs and competitions	22	24.7	**47**	**52.8**	16	18.0	2	2.2	2	2.2	89
8. Talked to family members about a science career	**45**	**50.6**	21	23.6	10	11.2	9	10.1	4	4.5	89
9. Talked to friends about a science career	**59**	**65.6**	15	16.7	5	5.6	8	8.9	3	3.3	90
10. Talked to teachers about a science career	**58**	**65.2**	20	22.5	3	3.4	6	6.7	2	2.2	89
11. Talked to family members about going to college	1	1.1	6	6.7	19	21.3	25	28.1	**38**	**42.7**	89
12. Talked to friends about going to college	6	6.9	14	16.1	**26**	**29.9**	17	19.5	24	27.6	87
13. Talked to teachers about going to college	18	20.2	19	21.3	**24**	**27.0**	14	15.7	14	15.7	89
14. Visited a college campus	31	34.4	**35**	**38.9**	18	20.0	3	3.3	3	3.3	90
15. Learned about how science can help people.	10	11.2	17	19.1	**22**	**24.7**	18	20.2	**22**	**24.7**	89
16. Learned about how science can solve problems in our environment.	5	5.6	18	20.0	18	20.0	24	26.7	**25**	**27.8**	90

Note: Modes are in bold. Total of percentages is not 100 because of rounding.

ISII items and demographic factors. Possible associations between socialization items and dichotomous demographic factors were calculated using the Mann Whitney U Test as it accounts for ordinal data. Comparing the two districts, students in RRISD reported more often participating in science fairs ($p < .01$), talking to family members about a science career ($p = .02$), and learning about science helping people($p = .02$; see Table 4 for distributions). Compared to students with at least one parent born outside the US, students with both parents born in the US reported more often watching science related TV shows ($p = .03$), playing outside in nature ($p < .001$), participating in hands-on science activities ($p < .01$), participating in science fairs ($p = .03$), visiting a college campus ($p = .02$), and talking to family, friends, and teachers about college ($p = .01$; $p = .04$; $p = .01$). Finally, compared to students without a parent in computer, engineering, or science careers (CES), students with at least one parent in these careers reported more often participating in hands-on science activities ($p = .01$), talking to family about a science career ($p = .04$), talking to family and teachers about college ($p = .04$; $p = .02$), learning about how science helps people ($p = .01$), and learning about how science can solve problems in the environment ($p < .01$).

Table 4
Group Differences on ISII items

	Differences by School District			
	RRISD (N = 48)		BISD (N = 39)	
ISII item	M	SD	M	SD
7.Participated in science fairs and competitions	2.25	.76	1.80	.90
8. Talked to family about a science career	2.19	1.27	1.66	1.06
15. Learned about how science can help people.	3.58	1.33	2.93	1.25

	Differences by Parent Birth Place			
	Both parents born in US (N = 50)		At least one parent born outside US (N = 32)	
ISII item	M	SD	M	SD
2. Watched science related TV shows	3.50	1.18	2.88	1.31
4. Played outside in nature	4.30	1.05	3.16	1.29
6. Participated in hands-on activities in science class	4.16	.88	3.41	1.21
7.Participated in science fairs and competitions	2.20	.94	1.74	.68
14. Visited a college campus	2.22	.97	1.78	1.00
12. Talked to friends about going to college	3.75	1.21	3.22	1.12
13. Talked to teachers about going to college	3.18	1.25	2.44	1.29
11. Talked to family members about going to college	4.31	.91	3.72	1.05

	Differences by Parent Occupation			
	1 parent in CES (N = 46)		No parent in CES (N = 40)	
ISII item	M	SD	M	SD
6. Participated in hands-on activities in science class	4.04	.97	3.61	1.16
8. Talked to family about a science career	2.04	1.26	1.76	1.11
11. Talked to family members about going to college	4.22	.97	3.83	1.05
13. Talked to teachers about going to college	3.04	1.32	2.58	1.38
15. Learned about how science can help people.	3.52	1.28	2.93	1.35
16. Learned about how science can solve problems in our environment.	3.80	1.17	3.12	1.27

I next looked for differences in response distributions by categorical demographic variables using the Kruskal-Wallis test that also accounts for ordinal dependent variables, but allows for more than two levels on the independent variable. Comparing students by first language spoken, there were significant differences for students regarding watching science related TV shows (p = .02), playing outside in nature (p = .01), participating in hands-on activities (p <.01), visiting college campuses (p < .01), learning about how science helps people (p = .02), and learning about how science can solve problems in the environment (p = .01). Post-hoc pair-wise comparisons showed that students who reported English as their first language and students who reported learning both English and Spanish at the same time had higher frequencies on all the items than students who reported Spanish as their first language (see Table 5). The two exceptions were for watching TV shows and playing outside in nature. In these two cases, English-first speakers only had higher frequencies than the Spanish-first speakers.

Table 5
Group differences by first language on ISII items.

	English first (N = 50)		Spanish first (N = 12)		Both English and Spanish (N = 26)	
	M	SD	M	SD	M	SD
2. Watched science related TV shows	3.50	1.09	2.42	1.00	3.04	1.43
4. Played outside in nature	4.08	1.22	2.83	1.40	3.73	1.19
6. Participated in hands-on activities in science class	4.13	.91	2.67	.99	3.85	1.05
14. Visited a college campus	2.06	.94	1.25	.62	2.31	1.09
15. Learned about how science can help people.	3.47	1.22	2.25	1.14	3.38	1.44
16. Learned about how science can solve problems in our environment.	3.65	1.19	2.50	1.00	3.69	1.29

Looking at parent education, only talking to family members about a career in science showed a difference by mother education (p = .03) with daughters of mothers with some college more likely to report talking about a science career to family than daughters of mothers without a high school diploma (M = 2.42, SD = 1.32; M = 1.33, SD

= .50). Father's education only showed a significant difference on talking to teachers about college ($p < .01$) with students who had a father with less than a high school education and students who had a father with some post-secondary schooling more likely to talk to teachers about college than students whose fathers had graduated from high school only (M = 3.71, SD = 1.49, M = 3.14, SD = .99, and M = 2.23, SD = 1.20, respectively). Finally, it should be noted that there were no significant differences in distributions based on self-reported SES rankings.

Exploratory factor analysis of ISII. I next looked for patterns in the socialization experiences of the students by performing an exploratory factor analysis on the ISII items following the recommendations of Russell (2002) and Costello and Osbourne (2005). I used a principal axis extraction method with oblim rotation (delta=0) to account for possible relations between factors. One subject was not used in the analysis because univariate and multivariate analysis determined her to be a significant outlier. The data were approximately multivariate normal according to the Bartlett Test of Sphericity (χ^2 (120) = 531.87, $p < .01$). However, the Kaiser-Meyer-Olkin measure of sampling adequacy was .69, under the .70 baseline, revealing that the distribution of values was slightly less than adequate for factor analysis. Therefore, these results should be interpreted with caution.

The requirement of eigenvalues over one resulted in a five factor solution that accounted for 67.94% of the total variance. However, this solution included five items with cross-loadings of over .30 on more than one factor and five items with loadings below .40. Solutions for three, four, six, and seven factors were also examined. A four factor solution, accounting for 61.41% of the total variance, was preferred because, eigenvalues leveled off on the scree plot after four factors, all factors had at least three items, and only two items did not have loadings above .40. These two items ("Played with science toys" and "Visited a college campus") were individually eliminated to produce a simple structure.

For a final analysis, the factor analysis was rerun with the remaining 14 items using principal axis factoring and oblim rotation. The factor loading matrix of this solution is presented in Table 6. Factor 1, science exposure, included the items concerning the impact of science along with hands-on experiences and TV watching. Factor 2, science career discussions, consisted of the three items asking how often students talked to significant others about careers in science specifically. Factor 3, college discussions, consisted of how often students talked to significant others about college plans in general. Factor 4, science enrichment, consisted of the remaining science experience items: visiting museums, reading books and magazines, playing in nature, and participating in science fairs.

An examination of items from the science exposure factor revealed that all items had distributions toward the high end of the scale, with most students reporting these experiences at least once a month. However, all items on the science enrichment factor had reported modes of less than once a month, with the exception of playing in nature.

Table 6
Summary of Items and Factor Loadings for Oblim Orthogonal Four-Factor Solution of ISII

	Factor			
	1	2	3	4
15. Learned about how science can help people.	**.91**	-.20	.36	.27
16. Learned about how science can solve problems in our environment.	**.89**	-.25	.26	.23
6. Participated in hands-on activities in science class	**.48**	.08	.24	.27
2. Watched science related TV shows	**.48**	-.20	.06	.47
9. Talked to friends about a science career	.21	**-.92**	.19	.17
8. Talked to family members about a science career	.28	**-.88**	.21	.38
10. Talked to teachers about a science career	.10	**-.78**	.21	.16
12. Talked to friends about going to college	.23	-.13	**.86**	.10
13. Talked to teachers about going to college	.32	-.25	**.73**	.30
11. Talked to family members about going to college	.26	-.17	**.70**	.22
5. Visited museums with science exhibits or activities	.24	-.20	.27	**.77**
1. Read science related books or magazines	.14	-.18	.02	**.50**
7. Participated in science fairs and competitions	.29	.00	.29	**.48**
4. Played outside in nature	.39	-.09	.27	**.41**
Factor correlations				
Factor 1	–			
Factor 2	-.14	–		
Factor 3	.31	-.14	–	
Factor 4	.38	-.19	.23	–

Factor analysis has acknowledged difficulties with items that have skewed distributions (Gorsuch, 1997) and several items on the ISII have this problem. Additionally, while all items had loadings above .40 on at least one factor, the items about watching science-related TV shows and playing in nature loaded almost equally on both Factor 1 and Factor 4. Finally, the four items corresponding to science exposure had an alpha of .78 and the four items corresponding to science enrichment had an unacceptable alpha of .56, indicating that alone these four items were not a reliable indicator of science enrichment for this sample. Considering this information, I combined items from Factor 1 and Factor 2 together into a single subscale, science experiences. Together these eight items had an acceptable reliability alpha of .76 with no dropping of items resulting in a substantial increase in the alpha.

I then checked the alpha reliabilities of the other two factors. The three college discussion items had an alpha of .80. The three science career items had an alpha of .88. Composite scores for each subscale were then created by meaning the items that loaded on each factor. Higher scores indicated students who experienced the events more often. I continued to use the ISII with these three subscales in subsequent analysis, referring to them as the college discussion subscale, the science career discussion subscale, and the science experiences subscale.

ISII subscales and demographic variables. I then looked for patterns in the IISI subscales by demographic variables. Independent sample t-tests found significant differences on the experiences subscale between RRISD and BISD ($t(87) = 2.60$, $p = .01$, *CI .95* [.09, .66], $d = .46$), generation status of students ($t(80) = 3.62$, p <.01 .01, *CI .95*

[.23, .82], d = .57), and if parents were in a computer, engineering, or science related career ($t(84) = 2.64$, $p = .01$, *CI .95* [.09, .66], $d = .70$). Students in RRISD reported more experiences on average than those in BISD ($M = 3.30$, $SD = .58$ versus $M = 2.92$, $SD = .74$). Students with a parent in a science-related career also reported more experiences ($M = 3.29$, $SD = .63$ versus $M = 2.90$, $SD = .69$). First-generation students reported less science related experiences ($M = 2.80$, $SD = .74$ versus $M = 3.33$, $SD = .59$) than those whose parents were both born in the US.

There were also significant differences on generation status ($t(80) = -3.04$, $p = .003$, *CI .95* [-.94, -.20], $d = .68$) for the college subscale. Students with at least one parent born outside the US were significantly less likely to report talking to significant others about college ($M = 2.79$, $SD = .87$ versus $M = 3.36$, $SD = .79$).

According to one-way ANOVA analysis, ISII science experiences and college subscales also showed significant differences by first reported language ($F(2, 86) = 9.18$, $p < .001$, eta squared = .18; $F(2, 86) = 3.66$, $p = .03$, eta squared = .08). Post-hoc tests showed that students who reported their first language as English had more science experiences than students who spoke Spanish as their first language ($M = 3.14$, $SD = .63$, 95% CI [2.97, 3.32]; $M = 2.29$, $SD = .36$, 95% CI [1.93, 2.65]). For the college subscale, students who first spoke Spanish were only significantly different from students who first spoke English ($M = 2.52$, $SD = .74$, 95% CI [2.04, 3.00] versus $M = 3.24$, $SD = .88$, 95% CI [3.01, 3.48]).

Mother's education level was a significant influence on the experiences subscale ($F(2, 69) = 3.26$, $p = .04$, eta squared = .09). Tukey HSD post hoc tests revealed that when mothers had less than a high school education, their daughters reported less science related experiences than daughters whose mothers had continued onto post-secondary schools (*M* = 2.50, *SD* = .75, 95% CI [2.03, 2.98]; *M* = 3.18, *SD* = .67, 95% CI [2.95, 3.41]). Father's level of education did not have a statistically significant effect on the subscales.

Finally, grade in school was not associated with the ISII subscales according to a one-way ANOVA analysis. Self-reported SES ranking also showed no correlations with the ISII subscales using Spearman's rho to account for the ordinal SES measurement.

Overall, students report various levels of science socialization experiences with young women reporting talking often to significant others about college and less often about careers in science specifically. These discussions and various science-related experiences were also related to some demographic factors, including first language spoken, generation status, district attended, parent education, and parent career.

Research Question #2: How are science socialization factors related to science outcomes associated with a science identity?

Intercorrelations. The first step to analyzing potential relations between socialization factors and science outcomes was to generate correlations. Using a .05 significance level, Pearson's product correlation identified significant relations between interval variables and Spearman's rho identified relations between the two ordinal variables, educational expectations and aspirations, and the other measures.

See Table 7 for a summary of the means, standard deviations, and intercorrelations of the measures. The ISII subscales were all significantly correlated with each other. None of the support variables were significantly correlated with the subscales, however, except for teacher support and science experiences. Only science experiences correlated with science grades. Educational aspirations were positively associated with the college discussions and science career discussions subscales, while educational expectations were only positively associated with the college subscale. Gender stereotypes showed no relations with the ISII subscales.

Regarding science related outcome measures, desire to do science was positively associated with science experiences and the science career discussions, while science anxiety was negatively associated with the same. Realistic and investigative career interests were positively associated with the science experiences subscale. In terms of science self-efficacy, all three ISII subscales were positively correlated with the two science self-efficacy scales, with the exception of college discussions and academic science self-efficacy as measured with the PALS scale.

Creating composite scores. Not unexpectedly, several of the measures showed significant correlations with each other. In order to reduce possible multicollinearity, three composite scales were created. This process also had the advantages of reducing the number of possible variables to test for in subsequent analysis, as well as creating variables that better aligned with the factors identified in the qualitative stage of the project. First, I created a science career interest composite scale by combining the realistic and investigate subscales as the two measures were significantly correlated ($r = .67$, $p < .001$), are originally subscales from the same test, and are conceptually related. The combined scale has an alpha of .88.

I created a second composite scale by combining the standardized scores from the desire to do science scale and science anxiety scale, reverse scoring the latter. These two measures were significant correlated ($r = -.57$, $p < .001$), are originally subscales from the same measure, and both asked questions about emotions generated by doing science. Thus, this composite scale was termed *emotions* to correspond to that factor identified in Stage 1. The combined scale has an alpha of .84.

The third composite was created by combining the standardized scores on the science self-efficacy and the PALS self-efficacy scales. Both of these measures were also highly correlated ($r = .63$, $p < .001$) and measure similarly perceived ability to do science-related school work. As the *using your brain* factor identified in Stage 1 shares many similarities with self-efficacy, this composite uses that factor name as well. The combine scale has an alpha of .87.

Table 7

Means, Standard Deviations, and Intercorrelations for Scores on Measures of Science Socialization and Science-Related Outcomes

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. College discussions	3.10	0.87	–															
2. Science career discussions	1.76	1.01	.24*	–														
3.Science experiences	2.98	0.69	.37**	.32**	–													
4.Desire to do Science	3.12	0.73	.03	.34**	.34**	–												
5.Science Anxiety	1.95	0.63	.08	-.34**	-.27**	-.57**	–											
6.Realistic Career Interests	2.93	0.84	-.13	-.01	.20	.30**	-0.12	–										
7.Investigative Career Interests	3.60	0.73	-.12	.21	.29**	.49**	-.45**	.67**	–									
8.Science self-efficacy	3.37	0.59	.23*	.31**	.35**	.41**	-.39**	.32**	.35**	–								
9. Academic science self-efficacy	3.68	0.86	.20	.27*	.43**	.48**	-.51**	.16	.37**	.63**	–							
10.Gender stereotypes	1.86	0.84	-.04	.16	-.01	-.03	.14	-.13	-.09	-.10	-.13	–						
11.Parent support	4.44	1.08	.02	.08	-.02	.06	.02	.06	-.11	.24*	.19	-.06	–					

Table 7 continued

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
12.Teacher support	5.03	0.94	.03	.04	.18	.44**	-.29**	.05	.04	.39**	.43**	.13	.30**	–				
13.Classmate support	4.19	1.13	-.03	-.06	-.06	-.01	.02	.06	-.13	.17	.07	.11	.41**	.29**	–			
14.Friend support	5.25	0.86	.01	.04	-.04	-.08	-.07	-.01	-.04	.11	.18	.12	.37**	.21	.43**	–		
15.School support	3.84	1.35	-.07	-.07	-.17	-.09	.03	.05	-.18	.11	.05	.04	.60**	.26*	.70**	.45**	–	
16.Science grades	87.24	8.04	.10	.13	.29*	.29**	-.15	.07	.16	.28**	.44**	-.11	-.01	.09	-.07	-.09	-.12	–

* p < .05. ** p < .01.

Regression analysis. The concept map generated in Stage 1 of the project (see Figure 5) guided regression analysis. This map identified *career planning* as the outcome variable and *home environment, teacher support, school experiences, emotions*, and *using your brain* as possible predictors. The *home environment* affinity was modeled with the parent support variable in the data set, the *teacher support* affinity modeled with the teacher support variable, the *emotions* affinity modeled with the emotions composite variable, and the *using your brain* affinity with the self-efficacy variable. *School experiences* were equated with both the ISII science experiences subscale as well as science grades. Finally, *career planning* was operationalized as the science career interest composite scale. The science career discussion subscale was also used as an outcome variable, as discussions about science careers with significant others could also be considered a measure of career planning. The following three hypotheses then resulted from relations detailed in the concept map:

1. Teacher support, parent support, science grades, science experiences, emotions, and self-efficacy will all positively predict science career interests.
2. Teacher support and parent support will have indirect effects on science career interests through the mediation of science grades, science experiences, emotions, and science self-efficacy.
3. Science grades and science experiences will have indirect effects on science career interests through the mediation of emotions and science self-efficacy.

To test the first hypothesis, I regressed the ICA science career composite variable (Y) on teacher support (TS), parent support (PS), the ISII science experiences subscale

(EX), science grades (SG), the emotions composite (EM) and the self-efficacy composite (SE), creating a simultaneous multiple regression equation of $Y = a + b_1TS + b_2PS + b_3EX + b_4SC + b_5EM + b_6SE + e$, where e is the error term. Regression results are shown in Table 8. The results indicate that the predictors explained 25% of the variance in science career interests. However, controlling for all the other variables, only emotions positively predicted science career interests.

Table 8
Regression Analysis Summary for Variables Predicting Science Career Interests

Variable	*B*	*SE B*	*Β*	*t*	*p*
Science grades	-.01	.01	-.08	-.76	.45
Teacher support	-.21	.11	-.22	-1.94	.06
Parent support	-.02	.09	-.03	-.28	.78
Emotions	.38	.13	.36	2.88	.01
Self-efficacy	.27	.14	.27	1.94	.06
Science experiences	.12	.14	.09	.83	.41

Note. $R^2 = .25$ (N = 86, p = .001)

Next, I reran the simultaneous multiple regression as above, but replaced the ICA science career composite outcome variable with the science career discussion scale (see Table 9). The results indicate that the predictors explained 23% of the variance in science career discussions. However, once again, only emotions significantly predicted discussions with others about science careers, controlling for the other variables.

Table 9
Regression Analysis Summary for Variables Predicting Science Career Discussions

Variable	*B*	*SE B*	*Β*	*t*	*p*
Science grades	-.01	.01	-.05	-.43	.67
Teacher support	-.25	.13	-.23	-1.94	.06
Parent support	.11	.10	.12	1.12	.27
Emotions	.43	.15	.35	2.77	.01
Self-efficacy	.15	.16	.13	.92	.36
Science experiences	.30	.17	.20	1.81	.07

Note. $R^2 = .23$ (N = 86, p = .001)

A post-hoc power analysis using GPower (Faul, Erdfelder, Lang, & Buchner, 2007) was conducted with a six predictor regression model, 86 person sample size, and an alpha level of $p < .05$. The program revealed the model to have more than adequate power (>.99) to detect large effects, slightly less than adequate power (.74) to detect moderate effects, and poor power (<.20) to detect small effects using Cohen's (1992) effect size conventions of $f^2 = .35$, .15, and .02, respectively. Therefore the results of the analyses with this sample size should be considered with caution as moderate to small effect sized relations were unlikely to be uncovered.

Testing of indirect effects. Simultaneous multiple regression only gives an estimate of the direct effects of predictors on outcomes; however, the model generated from Stage 1 posits several indirect relations. While no direct effects may exist from a particular predictor, it may have indirect effects through a mediating variable. To test for the indirect effects specified in Hypothesis 2 and Hypothesis 3, I used regression-based, path-analytic mediation analysis as described by Hayes (2013). This process utilized ordinary least squares (OLS) regression in SPSS with the PROCESS macro that allows for testing of indirect effects with bootstrap confidence intervals. All bias-corrected bootstrap confidence intervals for indirect effects are based on 10,000 samples and require the interval to be entirely above zero to be considered significant.

To test Hypothesis 2, the regression model used parent support and teacher support as independent variables, the science career composite scale as the dependent variable, and science experiences, science grades, emotions, and self-efficacy as parallel mediators (see Figure 9 for model and Table 10 for results). In this model, parent support showed no significant relations with any of the mediators and no direct or indirect relations with the science career scale. Teacher support significantly predicted emotions, self-efficacy, but not science experiences or science grades. Controlling for all other variables, science career interests were only directly predicted by emotions, as was found in the previous analysis. Of most interest, teacher support had a significant indirect effect on science career interests through emotions (b = .15, SE = .08, *95% CI* [.03, .34]).

My next regression model was to test the same model as above, but with the ISII science career discussion subscale as outcome (see Table 11). The relations between the predictor variables and the mediators remained the same. As before, parent support had no significant relations with the mediators or the outcome and science career discussions was only directly predicted by emotions, controlling for the other variables. Teacher support, again, had significant indirect effects on science discussions through emotions (b = .17, SE = .09, *95% CI* [.03, .38]).

My final regression models tested Hypothesis 3 and the possible mediation of school experiences and science career interests through self-efficacy and emotions. In this model, the ISII science experiences subscale and science grades were the independent variables, emotions and self-efficacy were mediators, and the science career composite was the outcome variable (see Figure 10). Results are shown in Table 12. Science career interests were only directly predicted by emotions. Bootstrap confidence intervals with 95% confidence support an indirect relation between science experiences and science career interests (b = .12, SE = .08, *95% CI* [.01, .35]) with emotions as a mediator.

I reran the model again, but used the ISII science career discussion variable as outcome. Results are shown in Table 13. Once again, emotions were the only direct predictor of science career discussions. Bootstrap confidence intervals with 95% confidence also support an indirect relation between science experiences and science career discussions (b = .12, SE = .09, *95% CI* [.002, .37]) with emotions as a mediator.

In summary, the regression models show that emotions about science were the strongest predictors of science career outcomes. Emotions acted as a mediator of the relation between teacher support and science career outcomes, so that students who reported greater science teacher support also had stronger positive emotions about science. Students with stronger positive feelings then were more likely to report talking to significant others about a career in science and to express an interest in science-related activates. Teacher support also influenced science career interests through science self-efficacy and science career discussions through science experiences. Additionally, science experiences had an indirect effect on science outcomes through emotions. Students who reported more science experiences had greater positive emotions about science and reported greater science career interests and discussions.

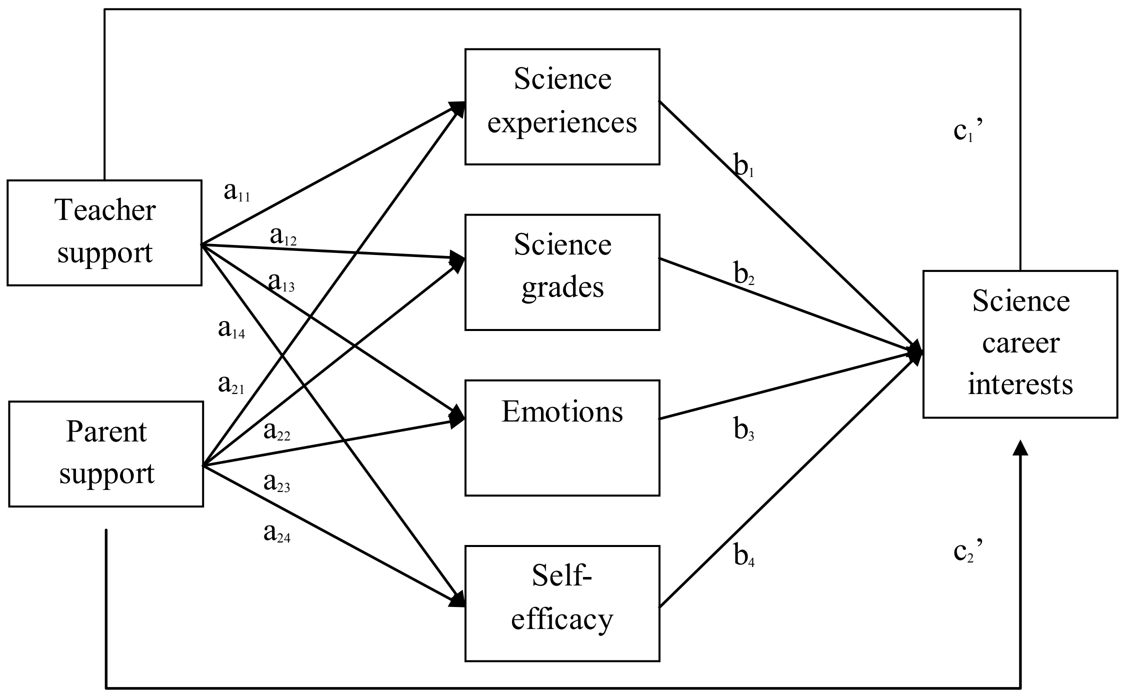

Figure 9. Model used for testing of indirect effects of teacher and parent support on science career interests through possible mediators of emotions, self-efficacy, science experiences, and science grades.

Table 10

Regression Analysis Summary for Mediation of Parent and Teacher Support on Science Career Interests through Science Grades, Science Experiences, Emotions, and Science Self-Efficacy (N = 86)

Antecedent		M_1 (science experiences)				M_2 (science grades)				M_3 (emotions)				M_4 (self-efficacy)				*Y* (career interests)		
		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X_1 (Teacher support)	a_{11}	.15	.08	.06	a_{12}	.89	.98	.36	a_{13}	.40	.09	<.001	a_{14}	.39	.09	<.001	c_1'	-.21	.11	.06
X2 (Parent support)	a_{21}	-.07	.07	.30	a_{22}	-.31	.85	.71	a_{23}	-.08	.08	.29	a_{24}	.09	.08	.26	c_2'	-.02	.09	.78
M_1 (science experiences)																	b_1	.12	.15	.41
M_2 (science grades)																	b_2	-.01	.01	.45
M_3 (emotions)																	b_3	.37	.13	.005
M_4 (self-efficacy)																	b_4	.27	.14	.06
Constant	i_{M1}	2.65	.44	<.001	i_{M2}	84.15	5.31	<.001	i_{M3}	-1.59	.49	.002	i_{M4}	-2.35	.51	<.001	i_Y	1.58	1.32	.23
		R_2 = .04 F(2,83)= 1.94, p = .15				R_2 = .01 F(2,83)= .42, p = .66				R_2 = .19 F(2,83) = 9.48, p < .001				R_2 = .19 F(2,83) = 9.48, p < .001				R_2 = .25 F(2,83) = 4.45, p <.001		

Table 11

Regression Analysis Summary for Mediation of Parent and Teacher Support on Science Career Discussions Through Science Grades, Science Experiences, Emotions, and Science Self-Efficacy

		M_1 (science experiences)				M_2 (science grades)				M_1 (emotions)				M_2 (self-efficacy)				Y (career discussions)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X_1 (Teacher support)	a_{11}	.15	.08	.06	a_{12}	.89	.98	.36	a_{13}	.40	.09	<.001	a_{14}	.39	.09	<.001	$c_1{}'$	-.25	.12	.06
$X2$ (Parent support)	a_{21}	-.07	.07	.30	a_{22}	-.31	.85	.71	a_{23}	-.08	.08	.29	a_{24}	.09	.08	.26	$c_2{}'$	.11	.10	.27
M_1 (science experiences)																	b_1	.30	.17	.07
M_2 (science grades)																	b_2	-.01	.01	.67
M_3 (emotions)																	b_3	.42	.15	.007
M_4 (self-efficacy)																	b_4	.15	.16	.36
Constant	i_{M1}	2.65	.44	<.001	i_{M2}	84.15	5.31	<.001	i_{M3}	-1.59	.49	.002	i_{M4}	-2.35	.51	<.001	i_Y	2.06	1.52	.18
		$R_2 = .04$ F(2,83)= 1.94, p = .15				$R_2 = .01$ F(2,83)= .42, p = .66				$R_2 = .19$ F(2,83) = 9.48, p < .001				$R_2 = .19$ F(2,83) = 9.48, p < .001				$R_2 = .23$ F(2,83) = 4.01, p = .002		

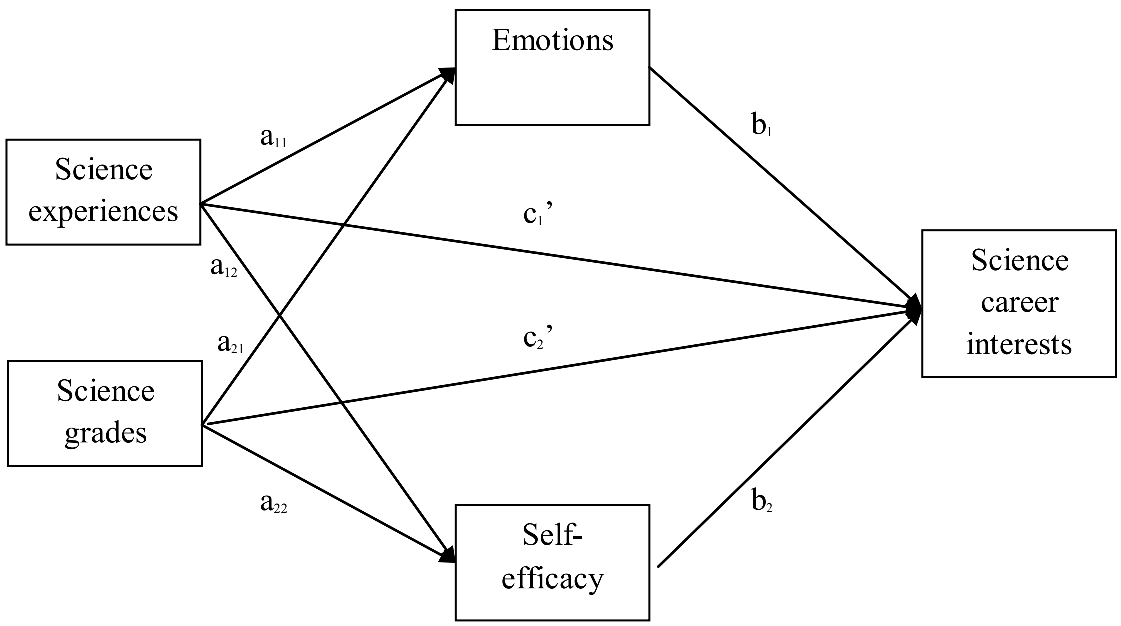

Figure 10. Model used for testing of indirect effects of science experiences and science grades on science career interests through possible mediators of emotions and self-efficacy.

Table 12

Regression Coefficients, Standard Errors, and Model Summary Information for the Science Career Interest Composite Parallel Multiple Mediator Model.

		Consequent										
		M_1 (emotions)				M_2 (self-efficacy)				*Y* (career interests)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X_1 (science experiences)	a_{11}	.37	.12	.006	a_{12}	.44	.13	<.001	c_1'	.29	.17	.09
X2 (science grades)	a_{21}	.02	.01	.12	a_{22}	.03	.01	.003	c_2'	-.004	.01	.76
M_1 (emotions)									b_1	.33	.15	.03
M_2 (self-efficacy)									b_2	.11	.15	.47
Constant	i_{M1}	-2.60	.92	.006	i_{M2}	-4.18	.91	<.001	i_Y	1.23	1.25	.33
		R_2 = ..15				R_2 = .26				R_2 = .19		
		F (2, 84) = 7.21, p = .001				F (2, 84) = 14.84, p < .001				F (4, 82) = 4.84, p = .002		

Table 13

Regression Coefficients, Standard Errors, and Model Summary Information for the Science Career Discussion Parallel Multiple Mediator Model

		Consequent										
		M_1 (emotions)				M_2 (self-efficacy)				*Y* (career discussions)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X_1 (science experiences)	a_{11}	.37	.12	.006	a_{12}	.44	.13	<.001	c_1'	.14	.15	.35
X2 (science grades)	a_{21}	.02	.01	.12	a_{22}	.03	.01	.003	c_2'	-.01	.01	.62
M_1 (emotions)									b_1	.33	.13	.01
M_2 (self-efficacy)									b_2	.17	.13	.18
Constant	i_{M1}	-2.60	.92	.006	i_{M2}	-4.18	.91	<.001	i_Y	.10	1.08	.93
		R_2 = ..15				R_2 = .26				R_2 = .21		
		F (2, 84) = 7.21, p = .001				F (2, 84) = 14.84, p < .001				F (4, 82) = 5.46, p = .001		

Chapter 5: Discussion

This discussion has three sections. The first and second sections discuss the results from the qualitative and quantitative stages of the project separately. The last section includes overall conclusions and observations, a discussion of the study limitations, and suggestions for future studies.

Qualitative Discussion

Overall, the individual concept maps for those in natural science/medicine and those in physical science/engineering/technology showed symmetry in the view of drivers and outcomes. For both groups of students, the home, outside context, and teachers were primary agents in creating a school environment that fostered their development in science. All students saw experiences in school as a gateway to a connection with science. These experiences allowed the young women to perform as scientists and receive feedback for that performance. Even tests were mentioned by students as influential as their comparative nature allowed them to recognize their abilities as something special.

The centrality of school experiences matches with the framework established by Carlone and Johnson (2007) who examined the science identity of college women of color. In their work, performance of science at the college level was key to the maintenance of a science identity. The retrospective results from this study suggest that performance of science in younger grades is also a necessary factor in the development of a science identity. Their successful participation in science then positively influenced both their emotions as well as their belief in their ability to do science.

The role of the media in the development of a science identity is less clear. That the affinity moved from primary driver for those in natural sciences/medicine to secondary outcome for those in physical sciences/engineering/technology indicates that the media is particular to the individual. This conclusion was born out in the interviews with individuals. While physical sciences/engineering/technology majors were less likely to endorse connections between *media* and the other affinities, natural science/medicine students were much more likely to emphasize its importance. For example, one pre-med student said, "To me, the most influential theme was the media because it wasn't until I began to watch all these doctor shows that I realized my interest in science and the healthcare field."

One possible difference for the importance of media could be the availability of medical-related shows on network and cable television, especially those that include young women in medical careers such as *Grey's Anatomy.* There are few TV shows that include young women as mechanical engineers or computer technicians. Even the most popular sitcom show about scientists, *The Big Bang Theory*, portrays its two regular, female scientist characters in the natural sciences. While a change in our societal expectations does not necessarily come from images in the media, when young women themselves claim the *media* to be influential on their career decisions, we should examine how young female scientists are being portrayed.

Additionally, as a component of the media, computers and related technology were seldom mentioned by the young women as influential. These young women are part of the "wired" generation, yet they spontaneously referred to computers only when discussing school research and occasionally career searches. Only one woman discussed being involved in any type of computer programming before college and that was not within an academic classroom, but on her own to improve her MySpace website. She later entered a technology field that requires coding.

In Texas at the time many of these women were in high school, no classes in technology or computers were required for high school graduation or admittance to college (Association for Computer Machinery, 2010). Perhaps consequently, The College Board reported that in 2012 that 3614 students in Texas took the AP Computer Science test and of those, 153 (4.2%) were Latinas. Compare these numbers to 13066 students who took the AP Biology exam including 2425 (18.6%) Latinas. When several theorists (Carlone & Johnson, 2007; Lent et al., 1994) emphasize the importance of active engagement in developing an identity, it should not be surprising that in areas where high school students have little experience in the subject, there are few who enter these majors in college.

Another surprising omission was any discussion of the role of school counselors. Although these young women were college bound in high school, not one student mentioned talking with a counselor in middle or high school as an influential experience. In some cases, students described talking to teachers about class and career choices, discussions that might be traditionally assumed to be part of a counselor's duties. However, the average counselor to student ratio in Texas is approximately 1 to 435, far exceeding the recommended ratio of 1 to 250 (American Counseling Association, 2011). Students may seldom have the chance to interact personally with a school counselor. A study by Corwin, Venegas, Oliverez, and Colyar (2004) documented how counselors at low-income, urban schools, overwhelmed with the high numbers of students and often required to take on administrative tasks, tend to concentrate on counseling only subgroups of students. Counselors may concentrate on behavioral issues of a small subset of students, acting as social workers and psychologists for those students. They may alternately choose to concentrate on the highest achieving students, offering these students college information and individual attention. As a result, counselors may have little time for the academic and career counseling of the majority of the school population, although they are often better trained than teachers to help students with navigating course and college selection choices.

Besides the changing nature of the *media* affinity, the IQA process of producing a linear concept map hid some additional relations in the data. For example, one of the two most commonly cited links for students was between *home environment* and *career planning* and many students referred back to their parents when discussing their career planning. While family was important for setting the foundation of a successful career, students also saw a STEM career as a way to give back to their families by supporting their parents and younger siblings. The direct link between the two affinities was obvious to many of the participants. However, because the nature of the IQA methodology emphasizes mediation, this relation was lost when creating the concept maps.

Additionally, a possible reciprocal relation exists between *school experiences* and *emotions*, as evidenced by their position changes in the concept maps for physical science/engineering/technology and natural science/medicine students. Some students indicated that positive school experiences led to good feelings about the science. However, other students saw an innate emotional interest in the subject as the primary drive to how they responded to school experiences. I would argue that students possibly had both experiences, where an innate interest drove them to participate in certain events and other times where an event drew forth an interest. As many students reported incidents from pre-school or early elementary when talking about their first exposure to science, it would be difficult, if not impossible, for many of the students to say whether they were born with an innate emotional attachment to science or whether their emotions were products of early experiences.

What is likely, however, is that without school experiences to either create or foster interest, there would be little development of a science identity. As an example of this, one student did report having limited positive science school experiences in elementary and high school. However, she reported high levels of internal interest and this interest was fostered by knowledge of career possibilities in STEM. While she has continued in science, she also talked about some ambiguity regarding her experiences.

The concept maps overall reflect the connections these young women made between different aspects of their lives. They talked about connections between school, outside lives, and future careers. This was especially evident when students discussed the *outside factors* affinity. In many cases, personal circumstances, such as a death in the family or involvement in sports, connected with some strong emotion. The women then turned to ideas of the future self to connect their emotions, their circumstances, and school experiences together. For example, a student who was a competitive athlete suffered an injury and the rehabilitation process introduced her to the physical therapy profession. She then connected that profession with the anatomy and physiology classes she liked in school. These connections between factors lead her to pursue physical therapy as a career. No student talked about a sole and singular influence. For all the interviewed participants, while they might acknowledge predominant factors, they also talked about the connections or web between the factors and how they were supported in their development in a myriad of ways. As in ecocultural theories of development, various settings and people are influencing these young women, and their development as scientists is through interactions between these factors and their individual differences.

Finally, the stories of these young women show that they have become adapt users and interpreters of community cultural wealth (Yosso, 2005). All the women demonstrated aspirational wealth in their academic work and long-term career goals. Their work was often supported by drawing on the experiences of others who had navigated the educational system, demonstrating social and navigational capital. Many women were taking advantage of their linguistic capital, using their language skills to procure more lucrative jobs or position themselves as valuable graduate student candidates. The importance of this type of community cultural wealth was emphasized when Latinas who only spoke English talked about feeling that they might be missing out on opportunities since they did not speak Spanish.

Quantitative discussion

First looking at the results of the univariate analysis, the reported science socialization experiences of the adolescent Latinas showed some similarities and some contrasts to the college population. Some items frequently mentioned by focus group participants were also highly endorsed by the younger students, such as visiting science museums, watching science-themed TV shows, and playing outside in nature. Playing in nature was an especially highly endorsed item, but there is limited mention of this factor in the literature on science interest development. However, the connections with a natural science interest are obvious as students that connect with the natural world viscerally are likely to use that experience as a starting point for academic investigations. That students were also likely to report engaging often in hands-on science activities is also an important connection with the performance aspect of developing a science identity.

However, the middle school population did not endorse all of the items generated from focus group discussions. For example, the middle school students reported low levels of playing with science-related toys and reading science themed books and magazines. It may be that this is due to still existing stereotype that these items are for boys, not girls, and that the young women in this survey had little access to play with such toys. In this case, the low responses are due more to lack of opportunity, than lack of interest. Looking back on the students in the focus groups who reported receiving science toys, interest followed from being given the toy. The students did not evident an interest first and then ask for the toy.

The lack of college visits and low levels of science fair participation also points to areas that could be addressed by schools working to increase interest in college and science participation. As many focus group students mentioned these experiences as influential, schools could work at incorporating these opportunities into the experiences of more students. This fits with the theoretical framework of Carlone and Johnson (2007) that science identity develops from both opportunity to perform science, as in a science fair, but also from acknowledgement of others in their abilities. Visiting college campuses would allow students to see themselves on campus and have that visceral experience, rather than a far away ideal self, without relation to reality.

Encouragingly, young Latinas are reporting high levels of college discussions with their parents. However, they were less likely to talk about college with teachers and with peers and very low levels of discussion surrounded science careers with either parents, teachers, or peers. This is perhaps not surprising considering the overall low levels of interest in science in the US (National Science Board, 2012). The low levels of discussions with teachers is especially worrying considering that many focus group participants saw teachers as important sources of information about college and about careers. Science teachers need to be encouraged to engage with students in college and career planning.

Turning to the multivariate analysis, the research hypotheses were only partially supported. First, while the qualitative results predicted several variables would directly influence science outcome variables, only emotions positively predicted science interests and science career discussions. Students who reported enjoying their science classes were more likely to have an interest in science activities and talk to significant others about science careers. Second, while self-efficacy and emotions were hypothesized as mediators between support and science outcomes, only emotions served as a mediator between teacher support and science outcomes. An increase in positive emotions following increasing teacher support was related to increasing discussions about science careers and science career interests. The third hypothesis was that self-efficacy and emotions mediated the relations between science experiences and grades on science outcomes. However, again, only emotions served as a mediator for science-related experiences. Controlling for grades, students who reported more science experiences had more positive emotions and these positive emotions were associated with increasing science interests and discussions about science careers.

For the students in the quantitative sample, emotions appear to be the key factor in determining science career outcomes and these emotions, in turn, are influenced by teacher support and by science experiences. Brain development could offer one explanation for the importance of emotions in the middle school population. At this age, the prefrontal cortex of the brain is still developing executive functions and adolescents are more likely to consider positive outcomes than negative ones (Blakemore, 2012). Students with highly positive emotions about a subject then may rely on that emotional evaluation, rather than a cognitive appraisal such as self-efficacy, when considering future plans.

That self-efficacy did not have an equal effect to that of emotions was surprising given the results from the qualitative study as well as previous studies that have strong support for self-efficacy as a predictor of science-related outcomes (Lent et al., 2001; Navarro, Flores, & Worthington, 2007). Self-efficacy does show strong correlations with science attitudes and outcomes in this study (see Table 7). However, it may be that due to the overwhelming effect of emotions, self-efficacy was not detectable with the low power of the sample. In the presence of emotions, self-efficacy is not as strong a predictor. Another possible reason for the non-significant effect could be developmental in that the middle school students have not completely associated career choices with their own abilities so that those with high science self-efficacy are no more likely to express an interest in science careers than those with low self-efficacy. As students enter high school, and begin to make class decisions based on college and career goals, self-efficacy may then play a bigger role.

Another surprising non-significant effect was for parent support. Again, the lower power of the sample may be a reason for this lack of finding. Alternatively, while the variable did not show a significant skew, many of the students rated their parents as positive supporters of their academic efforts. With the voluntary sample used in this study, I was less likely to sample students with low levels of parent support and less engagement with school. With greater variability in the sample, an effect would possibly have been detected. Another explanation is that given a minimal level of support from parents, student interests are guided by other factors. As the majority of students in this sample felt they had adequate parental support, other factors, such as emotions, became the driving force of science outcomes.

Overall Discussion

Overall, results from both the quantitative and qualitative stages of this study support a general conceptual model for developing Latina science identity (Figure 11). Parents and teachers are primary drivers in the model, with parents' acting to create an academic environment and teachers' acting to provide more specific information on science subjects and careers. Following from these important relations are then contextual factors, the influence of media, and, most importantly, school experiences. These various circumstances act together to promote nascent interests and identities by providing opportunities for performance and vicarious learning experiences. When positive, these experiences then lead to positive emotions and cognitive beliefs about one's ability and desire to do science. Strong positive attitudes contribute to the ultimate outcome of planning for a career in STEM.

The conceptual model is depicted as a linear arrow, but the factors should not necessarily be thought of as acting on the outcomes only through the mediating variables. While the quantitative results found support for some mediated pathways from drivers to outcomes, there was also evidence of direct effects. Thus the factors are depicted as points along one continuous arrow, rather than individual arrows leading neatly from one factor to the next to the next. The single arrow is also an attempt to visualize that when one or even several factors are absent in a lifestory, a person may still develop a science identity when the other factors are present and strong. Missing one link in the process will not force someone out of the pipeline. However, the other factors may need to be stronger to compensate for the loss.

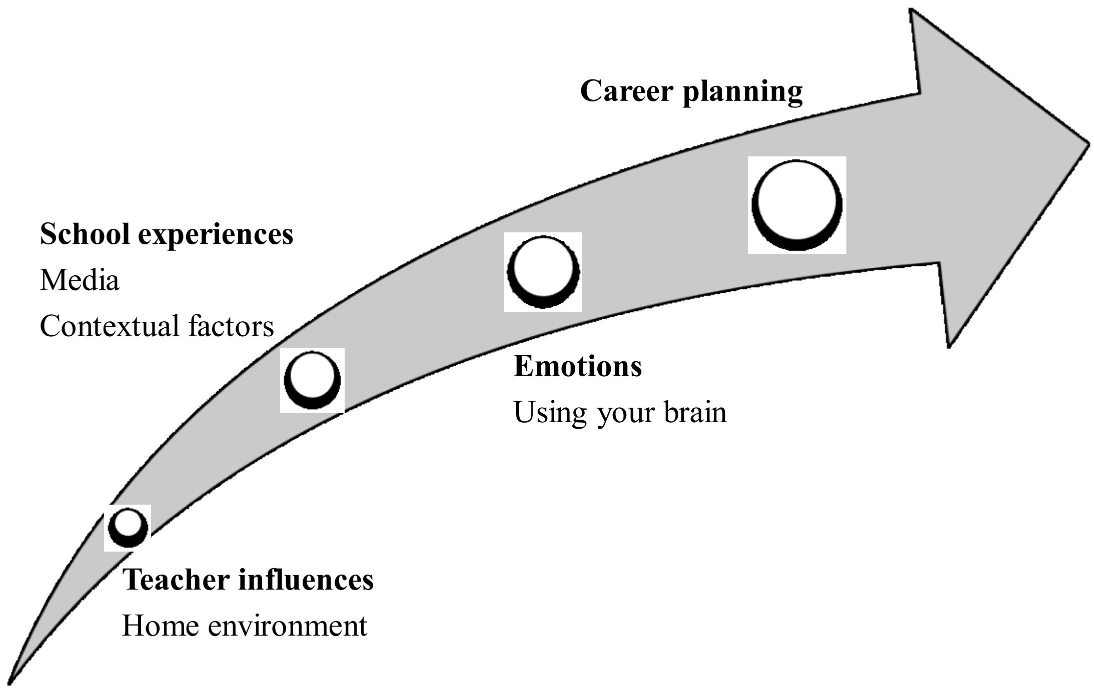

Figure 11. Conceptual model of the development of science identities in Latina adolescents. Affinities developed in the qualitative stage and supported in the quantitative stage are in bold.

The results of this mixed methods study also offers some convergent support for Lent, Brown, and Hackett's social cognitive theory of career development (SCCT; 1994). In the SCCT model, self-efficacy, and ultimately career interests, results from performance acts, modeling, social persuasion, and physiological reactions that include emotional reactions to an activity. The model generated in this study found that science interests resulted from science experiences (similar to performance acts), social support (similar to social persuasion), and emotions (similar to physiological reactions). That the young women in this study independently endorsed similar concepts to the SCCT framework demonstrates the potential importance and universality of these factors.

Additionally, SCCT describes how "contextual determinants," or opportunity structures in the environment, influence the eventual link between career interests and career goals. The results from this study also support the importance of these structures in two ways. First, many of the young women in the focus groups and interviews were aware of how environmental factors, such as the opportunities afforded at their schools, impacted their interest. Second, analysis of the adolescent survey data found relations between science experiences and demographic factors such as generation status and school district. Students that likely had links to better opportunity structures, either through their schools or through their families, reported having more experiences with science-related activities. These activities were then later linked to interest.

The study results, however, also have some significant differences with the SCCT model. One difference between the results from this study and the general SCCT model is the importance of self-efficacy. Self-efficacy is the lynch pin of SCCT. In the model, background variables of support and performance experiences are all filtered through self-efficacy judgments and self-efficacy continues to have direct and indirect influences on outcome variables of interest, goals, and behaviors. However, neither the qualitative nor the quantitative results from this study support the power of self-efficacy over other factors. Rather, in general, the focus groups and interviews found school learning experiences to be the fulcrum, with self-efficacy and emotional connections as following factors. The survey results also found limited connections between self-efficacy and interest outcomes, with emotions rather as the predominant factor. Possible reasons for the lack of self-efficacy findings were discussed in the above section. What needs to be emphasized here is that SCCT includes little acknowledgement of emotions in its model.

In the SCCT model, emotions are only tangentially influential on self-efficacy and it posits that the influence of emotional reactions would be dwarfed by the influence of performance experiences. However, this was the opposite of what was found in the middle school survey sample with emotions as a greater predictor of interest outcomes than self-efficacy and science-related experiences only influencing outcomes through an emotional mediator. A possible reason for this difference is developmental. While emotions were a strong component of the middle school sample, the college-aged sample did not especially endorse the importance of emotions over the other factors. Perhaps, and not surprisingly, for students in young adolescence emotions are the most important factor in determining a potential career direction. As they age, however, students may rely less on emotional reactions and more on practical considerations, such as employment opportunity. In that case, the SCCT model may be a better explanation of career choice for older students than as a developmental model that can be used to trace and predict outcomes from first schooling to first full-time employment.

Many career development theories have focused on the cognitive aspects of career development with only brief attention paid to the emotional and social processes that also fuel development (Kidd, 2004). However, the importance of emotions in career development is an emerging area of research (Hartung, 2011). Previous studies have found that emotions play a key role in the memory narrative people create about their career development, a phenomena that was observed in the qualitative portion of this study (Bubany, Krieshok, Black, & McKay, 2008; Young, Paseluikho, & Valach, 1997). Additionally, the survey results from the current study extend the importance of emotions in career interest development to younger ages than has been found in previous studies using college students (Puffer, 2011; Saka, Gati, & Kelly, 2008).

Turning from SCCT and to the model developed by Carlone and Johnson (2007) that looked specifically at college women of color, this study found some support for their three-phase model of science identity development. Their research identified three core areas of competence, performance, and recognition, and found that recognition was the most important for the identity development of women in their sample. Competence and performance overlap with science experiences, grades, and self-efficacy from the quantitative part of this study and with using your brain and school experiences from the qualitative part of this study.

Recognition by others is not as clear-cut in this model, with support being a more general concept. Students in the focus group and interview section of this study talked about recognition from teachers in two ways: either as acknowledgement for some academic accomplishment or as acknowledgement that their gender and ethnicity was different from a “typical” STEM student. In most cases, this second type of recognition was seen as positive by the women, a way to stand out in a large school, and the women saw the recognition by professors or teachers as a sign of encouragement. Few students recounted negative experiences as were discussed by Carlone and Johnson (2007). This may be due either to a cohort effect or because most of the women in Carlone and

Johnson's study were primarily interested in research science, while the women in this study had a wider array of interests.

Limitations and Future Extensions

There are methodological limitations to the proposed study. First, in Stage 1, the use of focus groups versus individual interviews may have limited the self-disclosure of some students. Some students may have been reluctant to discuss their influences within a group setting as opposed to one-on-one interviews. However, the hope of using this communal data collection method is that students would be validated in their experiences and build on each other's input. Additionally, as I am an older student and not Latina, my outsider position may make students feel less comfortable with disclosure. However, many participants thanked me for the opportunity to talk about their lives and to personally examine their own influences and motivations.

IQA is also a relatively new methodology with limited examples of use in the literature. Overall, I found the focus group methodology with the use of cards and group sorting to be a comfortable way to get all students to share their experiences. Several times participants would chime in that they had had a similar experience to one described on a card by another participant. I think this finding and sharing of commonalities helped open up the discussion.

The creation of the affinities and concept maps was the most difficult part of using the IQA methodology. Despite the use of spreadsheets and concept mapping, the process is a qualitative process that requires subjective judgments and decisions. IQA emphasizes its use of protocols for creating tables and drawing diagrams, but it is ultimately up to the researcher to bring meaning to the data (Marshall & Rossman, 2011).

Another limitation of the project is that the primary instrument for data collection, the ISII, was designed for this study with no previous studies of its validity or reliability. While the use of member checking helped address some of these concerns, it also revealed a flaw in the design of the ISII, the lack of specific computer experience questions. The ISII was written after focus group meetings, but before interviews took place, and there were relatively few participants in computer and technology majors in the focus groups. While this problem reflects their under-representation in school itself, it also led to an oversight in the creation of the inventory. When an interviewee in technology was shown the inventory, she did point out this problem. However, the survey had already been administered to one of the participating districts. It would have been interesting to gather data on computer usage with this younger group of students. Future studies could address this problem by examining the computer experiences of young Latina adolescents more specifically.

Another limitation in the study was the low alpha of the ethnic identity centrality scale. Due to the low reliability, I could not include the scale in the quantitative analysis and thus was not able to determine if centrality of ethnic identity influenced outcomes in this study. As the adolescent survey was originally designed, the ethnic identity centrality scale was to follow the gender centrality scale. The response options for both scales were shared as they were both derived from Cameron's social identity model (2004). However, when the gender centrality scale was changed to a gender stereotype scale on the request of one of the participating districts, the flow between the two scales was lost. The switch between asking questions about science ability to asking questions about ethnic identity may have been jarring for students and lead to confusion when answering the prompts. Student might also have struggled with comprehension on the two reverse coded questions. Only one other item on the adolescent survey to that point had been reverse coded, with almost all items except those related to science anxiety as positively worded. In fact, the two positively worded items on the ethnic identity centrality scale were significantly correlated with each other ($r = .70$) lending support to reading comprehension as a possible confound in the low scale alpha.

In terms of methodology, the low response rate to the surveys is also a factor in the findings. As the middle school students were offered no compensation for their time, the surveys were likely filled out by more academically invested students and students who were attracted to a science-themed survey. If this was the case, relations between factors could be skewed to represent students who already are developing science identities, rather than a more general population. Therefore, as always, caution should prevail when attempting to generalize findings to a wider population.

The smaller sample size also restricted the choice of analysis. While structural equation modeling would be a natural fit for testing the qualitatively derived models, sample sizes less than 100 are not recommended for SEM (Kline, 2005). As I collected data from entire student populations in addition to the Latinas featured in this study, I will in the future use SEM to test models for group differences, as well as overall fit of the IQA derived model versus models derived from literature.

Career interests and choices follow a developmental path. However, this study is not longitudinal and therefore only captures a snapshot of Latinas' career interests. The college student focus groups may have inadvertently neglected influential people and behaviors. Additionally, a cohort effect may take place where the influences upon the college age sample differed from the middle school sample. Despite these possible problems, I believe that use of older students who have made some commitment to science by declaring a major is important to elucidating the influences on younger students. The older students are not long removed from the secondary school system and were able to reflect with sufficient detail on the reasons for their interest. A longitudinal study with interviews that take place over the course of a participant's academic career would be an alternative to this type of cross-sectional study.

Finally, I should note that this research took place in central Texas, with a predominately Mexican American population. Latinos are a large and diverse group with various histories and current circumstances. Even within this small sample, proxies of immigration status, such as first language use, were found to correlate with science experiences. Therefore, findings from this study may not then generalize to other Latino groups or Mexican Americans in other geographic areas.

Conclusions

I set out in this study to understand how Latina adolescents develop a science identity and how people and environments support them in this process. By working with the women in the focus groups and interviews, I have found that overall they view their development in a positive light, with great appreciation and awareness of opportunities provided for them by parents and teachers. Yet, they were also aware of areas, particularly within their neighborhood and school environments, in which they could have been offered more support and more opportunities.

A trend in the current occupational development literature is to look at these “barriers” faced by women and students of color within the STEM fields (Lent et al., 2001). However, the use of barriers implies some sort of deliberate structure that stands in the way, blocking a path. Rather, the opportunities endorsed by women in the focus groups and interviews, yet that found little endorsement in the middle school survey, makes me think that the young women currently in our education system are not so much facing barriers, as they are facing the consequences for our society’s sins of omission.

Tight education budgets in underfunded school districts means “extras” such as field trips to college campuses and science museums are cut from the school year schedule. An outcome of high stakes testing is that science fairs are not held in order to make time for test reviews. Even within our homes, parents may buy a young girl a pretend stethoscope and doctor bag, yet not a microscope or chemistry set. Science toys are not commonly advertised on TV; we should not expect all young children to ask for microscopes on their own initiative. Science learning experiences are key to developing a science identity. All of these experiences provide young Latinas with the chance to perform as scientists, use the language of scientists, and be recognized as potential scientists.

Not all students are receiving equal access to these important science learning experiences. The discrepancies in access, especially at young ages when emotional connections are first forged, should become a larger focus of the STEM discussion.

Educators and administrators need to look at increasing opportunities for fun activities that engage students with science, especially surrounding topics in the physical science and technology. The problem is not just that Latinas are falling out of the STEM pipeline at high school and college, but that we as a society have not yet built the structures that give equal access to the pipeline.

Appendix A: Consent and Assent Forms

Focus groups and interview consent form

Study Number: 2012-08-0005
Approval Date: 1/7/2013
Expires: 1/6/2014

Consent for Participation in Research

Title: Latina students' science interests

Introduction
The purpose of this form is to provide you information that may affect your decision as to whether or not to participate in this research study. The person performing the research will answer any of your questions. Read the information below and ask any questions you might have before deciding whether or not to take part. If you decide to be involved in this study, this form will be used to record your consent.

Purpose of the Study
You have been asked to participate in a research study about **Latina students' interest in science.** The purpose of this study is to **learn what factors influenced Latina college students to enter a science-related major.**

What will you to be asked to do?
If you agree to participate in this study, you will be asked to **participate in a focus group and later respond to follow-up email questions. You may also be asked to participate in an individual interview. If you are invited to participate in an interview, you will have an opportunity to discuss this process and decline at that time.** This study will take **approximately one hour for the focus group and up to a half-hour for two email responses. The interview would also take an hour.** Approximately **24 to 40** study participants will be included in the focus groups and **5 to 7** study participants in the interviews.

Your participation **will** be **audio** recorded.

What are the risks involved in this study?
There are no foreseeable risks to participating in this study.

What are the possible benefits of this study?

You will receive no direct benefit from participating in this study; however, **we hope to learn about ways we can get more children involved in science careers through this research.**

Do you have to participate?
No, your participation is voluntary. You may decide not to participate at all or, if you start the study, you may withdraw at any time. Withdrawal or refusing to participate will not affect your relationship with The University of Texas at Austin (University) in any way.

If you would like to participate, please **return this form to the focus group coordinator**. You will receive a copy of this form.

Will there be any compensation?
For participating in this study, you will receive $10 after completion of the focus group.

If you are completing this study as part of a subject pool assignment, your professor determines credit for your participation in this study. When you complete the study, the subject pool website will be updated within 48 hours. If you choose not to participate in this study, you must notify the subject pool coordinator to obtain an alternative assignment.

What are my confidentiality or privacy protections when participating in this research study?
This study is **confidential** and **data collected will be stored securely and kept confidential.**

If you choose to participate in this study, you **will be audio** recorded. Any **audio** recordings will be stored securely and only the research team will have access to the recordings. Recordings will be kept for **one year** and then erased. The data resulting from your participation may be used for future research or be made available to other researchers for research purposes not detailed within this consent form.

Whom to contact with questions about the study?
Prior, during or after your participation you can contact the researcher **Karen Moran Jackson** at **512-850-XXXX** or send an email to **karenmoranjackson@utexas.edu.**

Whom to contact with questions concerning your rights as a research participant?
For questions about your rights or any dissatisfaction with any part of this study, you can contact, anonymously if you wish, the Institutional Review Board by phone at (512) 471-8871 or email at orsc@uts.cc.utexas.edu.

Participation

If you agree to participate **return this form to the focus group administrator.**

Signature
You have been informed about this study's purpose, procedures, possible benefits and risks, and you have received a copy of this form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time. You voluntarily agree to participate in this study. By signing this form, you are not waiving any of your legal rights.

____
Printed Name

_________________________________ _________________
Signature Date

As a representative of this study, I have explained the purpose, procedures, benefits, and the risks involved in this research study.

____
Print Name of Person obtaining consent

_________________________________ _________________
Signature of Person obtaining consent Date

Survey parent consent form and student assent form

Parental Permission for Children Participation in Research

Title: Science Interest in Middle School Students

Introduction
The purpose of this form is to provide you (as the parent of a prospective research study participant) information that may affect your decision as to whether or not to let your child participate in this research study. The person performing the research will describe the study to you and answer all your questions. Read the information below and ask any questions you might have before deciding whether or not to give your permission for your child to take part. If you decide to let your child be involved in this study, this form will be used to record your permission.
Purpose of the Study
If you agree, your child will be asked to participate in a research study about middle school students' interests in science. The purpose of this study is learn what factors influence middle school students' interests in science.

What is my child going to be asked to do?
If you allow your child to participate in this study, they will take several short surveys. This will take less than an hour and there will be about 500 other people in this study. We will also obtain your child's school records (grades and achievement test scores) with your permission from the district.
What are the risks involved in this study?
There are no foreseeable risks to participating in this study.
What are the possible benefits of this study?
Your child will receive no direct benefit from participating in this study; however, we hope to learn about ways we can get more children involved in science careers through this research.
Does my child have to participate?
No, your child's participation in this study is voluntary. Your child may decline to participate or to withdraw from participation at any time. Withdrawal or refusing to participate will not affect their relationship with The University of Texas at Austin (University) in anyway. You can agree to allow your child to be in the study now and change your mind later without any penalty.
What if my child does not want to participate?
In addition to your permission, your child must agree to participate in the study. If you child does not want to participate they will not be included in the study and there will be no penalty. If your child initially agrees to be in the study they can change their mind later without any penalty.
Will there be any compensation?
There is no compensation for participating in the study.
What are the confidentiality or privacy protections for my child's participation in this research study?
This study is confidential and no information about any individual will ever be disclosed. Data collected will contain identifying numbers, not names. The data will contain no identifying information that could associate your child with it, or with your child's participation in any study. The records of this study will be stored securely and kept confidential.
Whom to contact with questions about the study?
Prior, during or after your participation you can contact the researcher Karen Moran Jackson at 512-850-XXXX or send an email to karenmoranjackson@utexas.edu. This study has been reviewed and approved by The University Institutional Review Board and the study number is 2013-02-0069.
Whom to contact with questions concerning your rights as a research participant?
For questions about your rights or any dissatisfaction with any part of this study, you can contact, anonymously if you wish, the Institutional Review Board by phone at (512) 471-8871 or email at orsc@uts.cc.utexas.edu.
Signature
You are making a decision about allowing your child to participate in this study. Your signature below indicates that you have read the information provided above and have

decided to allow them to participate in the study. If you later decide that you wish to withdraw your permission for your child to participate in the study you may discontinue his or her participation at any time. You will be given a copy of this document.

____

Printed Name of Child

__________________________________ __________________

Signature of Parent(s) or Legal Guardian Date

Karen Moran Jackson

__________________________________ __4/30/13_________

Signature of Investigator Date

Permiso de los Padres para la Participación de Niños en una Investigación

Título: Interés del estudiante de escuela media en la ciencia

Introducción

El propósito de este formulario es ofrecerle (como el padre de un participante prospecto en este estudio de investigación) información que pueda afectar su decisión de permitir que su hijo/a participe en este estudio de investigación. La persona que realiza la investigación le describirá el estudio y responderá todas sus preguntas. Por favor, lea la siguiente información y haga cualquier pregunta que tenga antes de decidir si desea permitir que su hijo/a participe. Si usted decide permitir que su hijo/a participe en este estudio, este formulario se utilizará para registrar su permiso.

Propósito del Estudio

Si usted está de acuerdo, se le preguntará a su hijo/a si desea participar en un estudio de investigación acerca del interees del estudiante de escuela media en la ciencia. El propósito de este estudio es para aprender que factores influencian el interés del estudiante de escuela media en la ciencia.

¿Qué le van a pedir a mi hijo/a que haga?

Si usted permite que su hijo/a participe en este estudio, se le pedirá que complete varias encuestas cortas. El tiempo estimado de participación será de menos de una hora y habrá cerca de 500 participantes en este estudio. También obtendremos el expediente escolar de su hijo/a (grados y resultados de los exámenes) con su permiso del distrito.

¿Cuáles son los riesgos involucrados en este estudio?

No hay riesgos predecibles en la participación de este estudio.

¿Cuáles son los posibles beneficios de este estudio?

Su hijo/a no recibirá ningún beneficio directo por su participación en este estudio; sin embargo esperamos que atravez de esta investigación aprendamos maneras para que más niños se involucren en las carreras de ciencias.

¿Mi hijo/a tiene que participar?

No, la participación de su hijo/a es voluntaria. Su hijo/a puede decidir no participar o puede dejar de participar en cualquier momento. El hecho de dejar de participar no afectará su relación con la Universidad de Texas en Austin de ningún modo. Usted inicialmente puede permitir que su hijo/a participe en el estudio y luego cambiar de opinión sin ningún tipo de sanción.

¿Qué pasaría si mi hijo/a no desea participar?

Además de su permiso, su hijo/a debe estar de acuerdo en participar en el estudio. Si su hijo/a no desea participar, no será incluido/a en el estudio y no habrá penalidad. Si su hijo/a está inicialmente de acuerdo en participar en el estudio, puede cambiar de opinión más tarde sin ningún tipo de sanción.

¿Habrá alguna compensación?

Ni usted ni su hijo/a recibirán algún tipo de pago por su participación en este estudio.

¿Qué protección hay con respecto a la privacidad y la confidencialidad de la participación de mi hijo/a en este estudio de investigación?

Este estudio es anónimo y los datos obtenidos no tendrán información de identificación que pueda asociar a su hijo/hija con los datos, o con su participación en ningún estudio. Los registros de éste estudio serán guardados de mandera segura y serán mantenidos en forma confidencial.

¿A quién contactar con preguntas acerca del estudio?

Antes, durante, o después de su participación, usted puede contactar a la investigadora Karen Moran Jackson al 512-850-XXXX o enviar un correo electrónico a karenmoranjackson@utexas.edu. Este estudio ha sido revisado y aprobado por La Junta de Revisión Institucional de la Universidad y el número del estudio es 2013-02-0069.

¿A quién contactar con preguntas con respecto a sus derechos como participante de la investigación?

Si usted tiene alguna pregunta acerca de sus derechos o si tiene cualquier descontento con cualquier parte de este estudio, puede contactar, anónimamente si así desea, a la Junta de Revisión Institucional al (512) 471-8871, o al correo electrónico, orsc@uts.cc.utexas.edu.

Firma

Usted está tomando la decisión de permitir que su hijo/a participe en este estudio. Su firma indica que usted ha leído la información presentada anteriormente y ha decidido permitir que su hijo/a participe en el estudio. Si más adelante decide que desea retirar su permiso para que su hijo/a participe en el estudio, puede descontinuar su participación en cualquier momento. A usted se le entregará una copia de este documento.

____
Nombre del Niño/a en letra de molde

________________________________ ________________
Firma del padre/madre o tutor legal Fecha

Karen Moran Jackson
________________________________ ____4/30/2013_____
Firma del Investigador Fecha

Assent for Participation in Research

Title: Middle school students' science interests

Introduction

You have been asked to be in a research study about middle school students' interests in science. This study was explained to your parents/guardians and they said that you could be in it if you want to. We are doing this study to learn what factors influence middle school students' interests in science.

What am I going to be asked to do?

If you agree to be in this study, you will be asked to complete several short surveys. This study will take less than an hour and there will be about 500 other people in this study.

What are the risks involved in this study?

There are no foreseeable risks to participating in this study.

Do I have to participate?

No, participation is voluntary. You should only be in the study if you want to. You can even decide you want to be in the study now, and change your mind later. No one will be upset. If you would like to participate return this form to your teacher or the survey administrator. You will receive a copy of this form so if you want to you can look at it later.

Will I get anything to participate?

You will not receive any type of payment for participating in this study.

Who will know about my participation in this research study?

The records of this study will be kept private. Your responses may be used for a future study by these researchers or other researchers.

Signature

Writing your name on this page means that the page was read by or to you and that you agree to be in the study. If you have any questions before, after or during the study, ask the person in charge. If you decide to quit the study, all you have to do is tell the person in charge.

________________________________ ______________________

Signature of Participant Date

Appendix B: Focus Group Protocol

Procedure Plan

Time	Activity
Prep	Have sign-in sheet set up for participants to write name and email address. Food set up in back of room. Consent forms, index cards and pens at each seat. An agenda is on the board (if available). Participants are greeted when they enter the room
0:00-0:05	**Orientation.** Introduce self and basic premise of the project. "Hi, my name is Karen and I'm a graduate student in Educational Psychology here at UT. Before I came back to school, I was a middle school science teacher in California and Texas. I'm working on my PhD now and I'm interested in how Latinas develop an interest in science and science careers. You have been asked to participate in this group because you a Latina majoring in a science or science-related field. You will be asked to discuss with the group what you think influences an interest in science and may be asked to share personal experiences. Our conversation is confidential, although I will audio tape and later transcribe the discussion. Your identity will be protected and your name will never be used beyond making sure you receive credit for your participation. Your participation is voluntary and you can leave if you feel you will not be able to participate. However, if you are here as part of receiving subject pool credit and decide to leave, you may be asked to do an alternative assignment."
0:05-0:10	**Consent form.** Introduce consent form and go over it briefly. Ask for students to sign the form and turn it in. The second copy is for them to keep. Point out that my phone and email are on the copy and that I can be reached either way if they have questions later on. Also discuss how you will email them at a later date with a summary of the discussion and some clarification questions. Pause for any questions before we start.
0:10-0:15	**Guided imagery warm-up exercise**. "In a few minutes, I am going to ask you to talk about your experience developing a connection to science. I want to try and understand how people become interested in science both as a subject and as a career. So to start, I'll ask you to close your eyes and relax by taking a few deep breaths. Put aside thoughts of other things going on outside this room. I want you to try and remember when you first discovered science. Think about incidents that may have occurred in your childhood, before high school. These experiences may have occurred at your home, your school, or maybe another location. What were you doing at the time? Were you at home or at school? Who was around you? Who did you talk to about your new passion? Did you talk with your parents? Other family? Your teachers? Your friends? What did

	they say? Reflect on all the thoughts you had about 'doing science'. What were you excited about? What were you concerned about? Who did you want to talk to? Were there people you were reluctant to talk to? Why?"
0:15-0:25	**Individual brainstorm**. Ask participants to silently write down on cards their thoughts and reflections. Write down single words, short phrases, or even pictures that come to mind. They may use as many index cards as they wish, but one idea per paper. Encourage writing by letting participants know that all thoughts are welcome and no one will criticize.
0:25-0:35	**Sharing and clarification**. Participants are asked to post their notes on the walls of the room. The facilitator then reads the cards out loud. Participants are asked to clarify the meaning of any ambiguous notes so that everyone in the group has an understanding. During the process, or after the final participant shares, extra notes may be added with additional reflections.
0:35-0:45	**Finding themes**. Participants are asked to silently examine all the cards on the wall and look for commonalities among the responses. Think about how they would group the responses. After a minute, ask the participants to stand up and actually move the notes into these groups. Everyone can move anyone else's cards. If several participants move the same card into different groups, it may be set aside to be discussed later. Subgroups can also be formed if one group seems very large.
0:45-1:00	**Defining themes.** Once most cards are placed in a group, the groups are named. The clearest or easiest group is usually named first. At this point, groups may be arranged into subgroups or divided if necessary to clarify meaning. Problematic cards may also be readdressed to see if they fit under any of the newly defined categories or should form a category of their own. The facilitator needs to look for groups that are really polarities of the same concept (e.g. positive feedback and negative feedback could be combined into a single feedback group). The facilitator can offer advice, but the final themes and titles should be a product of the group discussion.
1:00-1:10	**Determining relationships**. Participants are given a blank Relationship Table and are asked to list the themes on the paper. Then, participants are asked to think about how different themes are related to each other—either A influences B, B influences A, or there is no relation. Participants record their individual responses on the paper.
1:10-1:15	**Conclusion and thank you**. Let participants know that time is coming to a close. Collect the Theme Relationship handout. Thank them for participating and let them know that you appreciate their candid discussion and opinions. Remind participants that you will be emailing them a copy of a composite mindmap created from this and other focus groups. In that email, you may ask them to clarify any questions that you

	have. You will ask them to respond to the themes and relations identified on the mindmap. You would appreciate their quick response to the email. Additionally, if anyone feels the need to add more to the discussion, they are welcome to stay after to talk to the facilitator or write an email later at a more convenient time. Remind them that your email is included on their copy of the consent form. Thank them again for their time.
1:15-	**Wrap-up.** After all participants have left, take pictures of card groupings and diagram on board. Collect papers and cards. Write up reflective notes on focus group. Clean up room.

Relationship Table Handout

Affinity Name

1.
2.
3.
4.
5.
6.
7.
8.

Possible Relationships

A → B

A ← B

A <> B (No Relationship)

Science interest development					
Theme Pair Relationship				Theme Pair Relationship	
1	2			3	6
1	3			3	7
1	4			3	8
1	5			4	5
1	6			4	6
1	7			4	7
1	8			4	8
2	3			5	6
2	4			5	7
2	5			5	8
2	6			6	7
2	7			6	8
2	8			7	8
3	4				
3	5				

Appendix C: Interview Protocol

Themes
Focus groups have identified the following common themes that contribute to an interest in STEM. You may find that some of these themes are more relevant to your personal story than others. However, as a group these were the most commonly mentioned factors.

1. Home environment
This theme describes how the participants' family (parents, siblings, other relatives) and close friends created an environment orientated toward academics and/or STEM. Participants discussed general support for academics, specific occupations of family members, and impactful events in the family.

2. Teacher influences
This theme reflects how particular teachers played a role in developing a subject interests. Characteristics of influential teachers included subject knowledge, high expectations, and enthusiasm.

3. School experiences
School experiences describe events that happened in a school setting that impact a subject interest. Some components of school experiences include:
Personally relevant and interesting topics
Hands-on engagement (i.e. experiments, science fairs)
Academic competitions (i.e. science fairs, UIL)
Field trips

4. Environmental factors
This theme describes how the background environment or personal situations became associated with a STEM interest for participants. Examples of outside factors include:
Childhood neighborhood and city
Exposure to nature
Moving and changing schools
Immigration

5. Media influences
This theme refers to how different forms of media impact an interest in STEM. Media discussed included specific TV shows, websites, and blogs.

6. Using your brain
This theme represents how participants viewed STEM as an intellectually challenging subject to study as well as a reflection on their innate ability in the subject.

7. Emotions
This theme concerns the emotions generated from studying STEM, as well as the actual and anticipated emotional rewards for participating in STEM classes and careers.

8. Career planning
Career planning describes how participants evaluated future career choices in STEM and how that played into their interest in the field.

Theoretical Coding
Many of the themes or affinities identified have some kind of relationship; one effects or causes the other. Let's look at each theme and decide if or how it relates to each other theme. Tell me about your experiences with such relationships. Please give specific examples of how the relationships have affected your experience.

Affinity Name
1. Home environment
2. Teacher influences
3. School experiences
4. Environmental factors
5. Media influences
6. Using your brain
7. Emotions
8. Career planning

Possible Relationships
A → B
A ← B
A <> B (No Relationship)

Affinity Relationship Table

AFFINITY PAIR		RELATIONSHIP	AFFINITY PAIR		RELATIONSHIP
1	2		3	5	
1	3		3	6	
1	4		3	7	
1	5		3	8	
1	6		4	5	
1	7		4	6	
1	8		4	7	
2	3		4	8	
2	4		5	6	
2	5		5	7	
2	6		5	8	
2	7		6	7	
2	8		6	8	
3	4		7	8	

Appendix D: Middle School Science Survey

Name: ___________________________ Grade: ____________

Science Interest Survey

On the following pages, you will be asked to answer questions about your experiences, attitudes, and beliefs about science, science class, and important people in your life. There are no right or wrong answers, you only need to give your truthful opinion. What you mark is confidential.

In most cases, you will be asked how much you agree or disagree with each statement. Read each item and fill in the bubble that best represents your opinion.

For example:

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
I like watching TV shows about science.	○	○	○	○	○

If you don't like watching TV shows about science, you would fill in the second bubble, like this:

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
I like watching TV shows about science.	○	●	○	○	○

If you really like watching TV shows about science, you would fill in the last bubble, like this:

	Strongly disagree	Disagree	Don't know	Agree	Strongly agree
I like watching TV shows about science.	○	○	○	○	●

It is important that you respond to *every statement*, and that you fill in only one bubble per statement. **You can use pen or pencil.**

Turn the page to begin.

Please mark **how often** you experience the following in elementary and middle schools:

	Never (0)	Once or twice in my life	Once or twice a year	Once or twice a month	More than twice a month
17. Read science related books or magazines	○	○	○	○	○
18. Watched science related TV shows	○	○	○	○	○
19. Played with science-related toys at home (microscopes, chemistry sets, telescopes, etc.)	○	○	○	○	○
20. Played outside in nature (collecting bugs, watching animals, identifying plants, looking at stars, etc.)	○	○	○	○	○
21. Visited museums with science exhibits or activities	○	○	○	○	○
22. Participated in hands-on activities in science class	○	○	○	○	○
23. Participated in science fairs and competitions	○	○	○	○	○
24. Talked to **family** members about a science career	○	○	○	○	○
25. Talked to **friends** about a science career	○	○	○	○	○
26. Talked to **teachers** about a science career	○	○	○	○	○
27. Talked to **family** members about going to college	○	○	○	○	○
28. Talked to **friends** about going to college	○	○	○	○	○
29. Talked to **teachers** about going to college	○	○	○	○	○
30. Visited a college campus	○	○	○	○	○
31. Learned about how science can help people.	○	○	○	○	○
32. Learned about how science can solve problems in our environment.	○	○	○	○	○

Indicate how much **you agree or disagree** with each statement.

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
33. Science is useful in helping to solve the problems of everyday life.	○	○	○	○	○
34. Most people should study some science.	○	○	○	○	○
35. Science is helpful in understanding today's world.	○	○	○	○	○
36. Science is of great importance to a country's development.	○	○	○	○	○
37. It is important to know science in order to get a good job.	○	○	○	○	○
38. Science is something that I enjoy	○	○	○	○	○

very much.					
39. I would like to do some extra or un-assigned reading in science.	○	○	○	○	○
40. Sometimes I read ahead in our science book.	○	○	○	○	○
41. I like the challenge of science assignments.	○	○	○	○	○
42. It is important to me to understand the work I do in science class.	○	○	○	○	○
43. Science is one of my favorite subjects.	○	○	○	○	○
44. I have a real desire to learn science.	○	○	○	○	○
45. When I hear the word *science*, I have a feeling of dislike.	○	○	○	○	○
46. I feel tense when someone talks to me about science.	○	○	○	○	○
47. It makes me nervous to even think about doing science.	○	○	○	○	○
48. It scares me to have to take a science class.	○	○	○	○	○
49. I have a good feeling toward science.	○	○	○	○	○

Read each item below and fill in the appropriate option of **how much you like it**.

	Don't like at all	**Don't like**	**So-so or OK**	**Like**	**Like a lot**
50. Build things	○	○	○	○	○
51. Hammer nails	○	○	○	○	○
52. Watch construction	○	○	○	○	○
53. Fix a toy	○	○	○	○	○
54. Watch someone fix a TV	○	○	○	○	○
55. Understand how things work	○	○	○	○	○
56. Take things apart	○	○	○	○	○
57. Watch a science show	○	○	○	○	○
58. Look in a microscope	○	○	○	○	○
59. Mix things together to see what happens	○	○	○	○	○

Indicate **your ability** to do each of the following statements below.

	Very low ability	Low ability	Uncertain	High ability	Very high ability
60. Earn an A in science.	○	○	○	○	○
61. Get an A in science in high school	○	○	○	○	○
62. Design and describe a science experiment that I want to do	○	○	○	○	○
63. Classify animals that I observe	○	○	○	○	○
64. Predict the weather from weather maps	○	○	○	○	○
65. Develop a hypothesis about why kids watch a particular TV show	○	○	○	○	○

Here are some questions about yourself as a student in science class. Please mark the circle that best describes **what you think**.

	Not at all true	Somewhat untrue	Somewhat true	True	Very true
66. I am certain I can master the skills taught in science class this year.	○	○	○	○	○
67. I am certain I can figure out how to do the most difficult science class work.	○	○	○	○	○
68. I can do almost all the work in science class if I don't give up.	○	○	○	○	○
69. Even if the science work is hard, I can learn it.	○	○	○	○	○
70. I can do even the hardest work in science class if I try	○	○	○	○	○

Indicate **how much you agree or disagree** with each statement.

	Strongly Disagree	Disagree	Disagree a little bit	Agree a little bit	Agree	Strongly Agree
54. It is possible that boys have more science ability than girls.	○	○	○	○	○	○
55. In general, boys may be better than girls at science.	○	○	○	○	○	○
56. I don't think that there are any real differences between boys and girls in science.	○	○	○	○	○	○
57. I often think about being a member of my ethnic group.	○	○	○	○	○	○
58. Being a member of my ethnic group has little to do with how I feel about myself in general.	○	○	○	○	○	○
59. Being a member of my ethnic group is an important part of my self image.	○	○	○	○	○	○
60. The fact I am a member of my ethnic group rarely enters my mind.	○	○	○	○	○	○

Please indicate **how ofte**n you receive the support described from each person.

	Never	Almost never	Some of the time	Most of the time	Almost always	Always
MY PARENTS:						
61. show they are proud of me.	○	○	○	○	○	○
62. understand me.	○	○	○	○	○	○
63. listen to me when I need to talk.	○	○	○	○	○	○
64. make suggestions when I don't know what to do.	○	○	○	○	○	○

65. give me good advice.	○	○	○	○	○	○
66. help me solve problems by giving me information.	○	○	○	○	○	○
67. tell me I did a good job when I do something well.	○	○	○	○	○	○
68. nicely tell me when I make mistakes.	○	○	○	○	○	○
69. reward me when I've done something well.	○	○	○	○	○	○
70. help me practice my activities.	○	○	○	○	○	○
71. take time to help me decide things.	○	○	○	○	○	○
MY SCIENCE TEACHER(S):						
72. cares about me.	○	○	○	○	○	○
73. treats me fairly.	○	○	○	○	○	○
74. makes it okay to ask questions.	○	○	○	○	○	○
75. explains things that I don't understand.	○	○	○	○	○	○
76. shows me how to do things.	○	○	○	○	○	○
77. helps me solve problems by giving me information.	○	○	○	○	○	○
78. tells me I did a good job when I've done something well.	○	○	○	○	○	○
79. nicely tells me when I make mistakes.	○	○	○	○	○	○
80. tells me how well I do on tasks.	○	○	○	○	○	○
81. makes sure I have what I need for school.	○	○	○	○	○	○
82. takes time to help me learn to do something well.	○	○	○	○	○	○
83. spends time with me when I need help.	○	○	○	○	○	○
MY CLASSMATES:						
84. treat me nicely.	○	○	○	○	○	○
85. like most of my ideas and opinions.	○	○	○	○	○	○
86. pay attention to me.	○	○	○	○	○	○
87. give me ideas when I don't know what to do.	○	○	○	○	○	○
88. give me information so I can learn new things.	○	○	○	○	○	○
89. give me good advice.	○	○	○	○	○	○
90. tell me I did a good job when I've done something well.	○	○	○	○	○	○
91. nicely tell me when I make mistakes.	○	○	○	○	○	○
92. notice when I have worked hard.	○	○	○	○	○	○
93. ask me to join activities.	○	○	○	○	○	○
94. spend time doing things with me.	○	○	○	○	○	○
95. help me with projects in class.	○	○	○	○	○	○

	Never	Almost never	Some of the time	Most of the time	Almost always	Always
MY CLOSE FRIEND:						
96. understands my feelings.	○	○	○	○	○	○
97. sticks up for me if others are treating me badly.	○	○	○	○	○	○
98. helps me when I'm lonely.	○	○	○	○	○	○
99. gives me ideas when I don't know what to do.	○	○	○	○	○	○
100. gives me good advice.	○	○	○	○	○	○
101. explains things that I don't understand.	○	○	○	○	○	○
102. tells me he or she likes what I do.	○	○	○	○	○	○
103. nicely tells me when I make mistakes.	○	○	○	○	○	○
104. nicely tells me the truth about how I do on things.	○	○	○	○	○	○
105. helps me when I need it.	○	○	○	○	○	○
106. shares his or her things with me.	○	○	○	○	○	○
PEOPLE IN MY SCHOOL						
107. care about me.	○	○	○	○	○	○
108. understand me.	○	○	○	○	○	○
109. listen to me when I need to talk	○	○	○	○	○	○
110. give me good advice	○	○	○	○	○	○
111. help me solve my problems by giving me information.	○	○	○	○	○	○
112. explain things that I don't understand.	○	○	○	○	○	○
113. tell me how well I do on tasks.	○	○	○	○	○	○
114. tell me I did a good job when I've done something well.	○	○	○	○	○	○
115. nicely tell me when I make mistakes.	○	○	○	○	○	○
116. take time to help me decide things.	○	○	○	○	○	○
117. spend time with me when I need help.	○	○	○	○	○	○

118. Looking ahead, how far do you **want** to go in school? **Check one box**.
- ☐ I want to quit school as soon as possible.
- ☐ I want to finish high school.
- ☐ I want to finish high school and attend a trade school.
- ☐ I want to finish high school and take some college classes.
- ☐ I want to finish high school and finish college (a Bachelor's degree).
- ☐ I want to finish high school, finish college, and then earn a graduate degree (a MD, a PhD, etc.)

119. Looking ahead, how far do you **expect** to go in school? **Check one box**.
- ☐ I expect to quit school as soon as possible.
- ☐ I expect to finish high school.
- ☐ I expect to finish high school and attend a trade school.

- ☐ I expect to finish high school and take some college classes.
- ☐ I expect to finish high school and finish college (a Bachelor's degree).
- ☐ I expect to finish high school, finish college, and then earn a graduate degree (a MD, a PhD, etc.)

120. What career or occupation would you like to have in the future?

____

121. What is your gender? **Circle one.** Male Female

122. What is the first language you learned to speak? **Circle one**.

English Spanish Both English and Spanish Other: ___________________

123. Where were you born? **Circle one**.

U.S. Mexico Other: ______________________

If you were not born in the US, how old were you when you moved to the US? ________

124. Where were your parents/guardians born? **Circle one**. If you have step-parents, answer for the parent who helps you the most with school. If you live with one parent, answer for just that parent.

Mother's birthplace:
U.S. Mexico Other:____________________ I don't know.

Father's birthplace:
U.S. Mexico Other:___________________ I don't know.

125. What is the highest level of education your **mother** completed? **Check one box**.
- ☐ Less than a high school or secondary school education
- ☐ Finished secondary school or high school (grade 12)
- ☐ Finished a trade school/associate degree
- ☐ Finished college
- ☐ Finished a Masters degree or other graduate school
- ☐ I don't know

126. Is your **mother** employed in the following fields? **Circle yes or no**.

Computer, engineering, or science	yes	no
Healthcare	yes	no

127. What is the highest level of education your **father** completed? **Check one box**.
- ☐ Less than a high school or secondary school education
- ☐ Finished secondary school or high school (grade 12)
- ☐ Finished a trade school/associate degree
- ☐ Finished college
- ☐ Finished a Masters degree or other graduate school

☐ I don't know

128. Is your **father** employed in the following fields? **Circle yes or no**.

Computer, engineering, or science	yes	no
Healthcare	yes	no

129. The biggest number (10) represents the people who have the most money, most education, and best jobs. The smallest number (1) are the people who have the least money, least education, and worst jobs or no job. **Circle the number** that best reflects your situation.

Lowest 1 2 3 4 5 6 7 8 9 10 *highest*

130. In this country, people come from many different countries and cultures, and there are many different words to describe the different backgrounds or ethnic groups that people come from. Some examples of the names of ethnic groups are Hispanic or Latino, Black or African American, Asian American, Chinese, Filipino, American Indian, Mexican American, Caucasian or White, Italian American, and many others.

Based on the reading above, please **fill in the blank** below.

In terms of my ethnic group, I consider myself to be ________________________.

The End.

Thank you for participating in this survey.

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