A DESCRIPTIVE STUDY OF HIGH SCHOOL LATINO AND CAUCASIAN STUDENTS’ VALUES ABOUT MATH, PERCEIVED MATH ACHIEVEMENT AND STEM CAREER CHOICE

By

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To the Faculty of Washington State University:

The members of the Committee appointed to examine the dissertation of Samuel Rodriguez Flecha find it satisfactory and recommend that it be accepted.

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A DESCRIPTIVE STUDY OF HIGH SCHOOL LATINO AND CAUCASIAN STUDENTS’ VALUES ABOUT MATH, PERCEIVED MATH ACHIEVEMENT AND STEM CAREER CHOICE

Abstract

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The purpose of this study was to examine high school students’ math values, perceived math achievement, and STEM career choice. Participants (N=515) were rural high school students from the U.S. Northwest. Data was collected by administering the “To Do or Not to Do:” STEM pilot survey. Most participants (n=294) were Latinos, followed by Caucasians (n=142). Fifty-three percent of the students rated their math achievement as C or below. Of high math students, 57% were male. Females were 53% of low math students. Caucasians (61%) rated themselves as high in math in a greater proportion than Latinos (39%). Latinos (58%) rated themselves as low in math in a greater proportion than Caucasians (39%).

Math Values play a significant role in students’ perceived math achievement. Internal math values (r =.68, R² =.46, p =.001) influenced perceived math achievement regardless of gender (males: r =.70, R² =.49, p =.001; females: r =.65, R² =.43, p =.001), for Latinos (r =.66, R² =.44, p =.001), and Caucasians (r =.72, R² =.51, p =.001). External math values (r =.53, R² =.28, p =.001) influenced perceived math achievement regardless of gender (males: r =.54, R²
=.30, p =.001; females: r =.49, R² =.24, p =.001), for Latinos (r =.47, R² =.22, p =.001), and Caucasians (r =.58, R² =.33, p =.001).

Most high-math students indicated an awareness of being good at math at around 11 years old. Low-math students said that they realized that math was difficult for them at approximately 13 years of age. The influence of parents, teachers, and peers may vary at different academic stages.

Approximately half of the participants said there was not a person who had significantly impacted their career choice; only a minority said their parents and teachers were influencing them to a STEM career. Parents and teachers are the most influential relationships in students’ career choice. More exposure to STEM role models and in a variety of professions is needed. Possible strategies to impact students’ career choice, future directions and recommendations are provided. In sum, positive experiences in STEM can favorably contribute to students’ sense of competence and satisfaction.
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DEDICATION

A Mami, Papi, Erica, Natalia y Andres.
CHAPTER ONE

Introduction

Need for the Study

Science, technology, engineering, and math (STEM) are essential to the economic development of the United States (e.g., Economics and Statistics Administration, 2011; He, 2007; Lindholm-Leary & Borsato, 2003; Sonnert, 2009). The demand for STEM skills is greater than the current supply (Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development, 2000; Gunderson, Ramirez, Levine, & Beilock, 2012; Patrick, Mantzicopoulos, & Samarapungavan, 2009). The populations that can provide the needed demand for STEM jobs are not being optimally engaged (Board on Science Education, 2011; Gallagher, 1996). The recruitment and retention of underrepresented groups in STEM remains one of the most prevailing issues facing U.S. higher education (e.g., Fox, 2008; Turner, 2000). The growth of underrepresented groups’ general population suggests that minority groups could eventually increase their representation in the educational system, naturally contributing to the national STEM career pipeline (Committee on Equal Opportunities in Science and Engineering [CEOSE]). There is still, however, a large educational attainment gap between racial/ethnic minorities and non-minorities (Gregory, 2003; Lane, 2001; Nora, 2004; Torres, 2004), resulting in the underrepresentation of racial/ethnic minorities in STEM.

In addition to the underrepresentation of racial/ethnic minorities, women are underrepresented in STEM (Board on Science Education, 2011; Cole & Espinoza, 2008; Graham & Smith, 2005; Lindholm-Leary & Borsato, 2003; National Center for Educational Statistics
Female underrepresentation worsens the farther along the pipeline (e.g., Cronin & Roger, 1999; Gallagher, 1996; Rosser, 2004). While some argue that underrepresented groups face barriers to academic success (e.g., Gregory & Tillman, 2003; Myers & Turner, 2004), some question whether women actively select out of STEM. The difficulties faced by females in STEM are, according to some, an issue of lack of confidence (e.g., Cole & Espinoza, 2008; Ermer, 2004). External factors (e.g., unsupportive academic environments; stereotyped expectations), however, may hinder the development of females’ STEM values, which predict academic achievement, particularly in high school (Durik, Vida, & Eccles, 2006; Fredricks & Eccles, 2005; Marsh, Gerlack, Trautwein, Ludtke, & Brettschneider, 2007; Sabiston & Crocker, 2008; Simpkins, Davis-Kean, & Eccles, 2006). The high school years have been found to be a critical stage as high school students’ academic values influence their post-secondary academic success (Adamuti-Trache & Andres, 2008; Wood, Kurtz-Costes, & Copping, 2011).

Despite efforts to deal with the underrepresentation of women in STEM, the situation appears far from resolved (Blickenstaff, 2005). Although women have greatly increased their representation in almost all areas of higher education, they continue to lag behind in STEM (Wylie, Jakobsen, & Fosado, 2007). Even when female representation in STEM disciplines has increased, females are still concentrated only in certain fields (De Welde, Laursen, & Thiry, 2007). Furthermore, 70% of females enrolled in STEM switch to other majors (Owens, Smothers, & Love, 2003). The emphasis on the recruitment of women to STEM fields in the last few decades, however, has resulted in an increase of female participation in STEM (Meece, Glienke, & Burg, 2006). Attention must be paid, however, to the situation of males as well, as
less and less males pursue a college career (Blue et al., 2005, Hoff-Sommers, 2000; Roenigk, 2011; Tabarrok, 2012).

Overall, more non-STEM majors graduate than STEM majors (Weiford, 2012). Changes in perceived ability explain most of the changes in academic interest over time (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002), and ultimately on achievement (e.g., Niewswandt, 2007; Nosek & Smyth, 2011). Perceived ability is strongly related to academic achievement (Meece et al., 2006). Perceived math ability decreases for all students as they advance in their schooling (Wigfield & Eccles, 2000; Wigfield, Eccles, Yoon, & Harold, 1997). Students who experience frustration and a lack of interest in science and math courses may see math and science as irrelevant and disengage from STEM (Creasy Fowler, 2010; Lyons, 2006; Patrick et al., 2009).

Math (Internal and External) Values: Influences on STEM Career Choice

Values are composed of perceptions, beliefs, and feelings about the interest, importance, and usefulness of an activity or issue (Eccles & Wigfield, 2002). Values are strongly related to career choice (Patrick et al., 2009; Eccles & Wigfield, 2002). Math and science values are important predictors of academic engagement and STEM achievement (Denissen, Zarrett, & Eccles, 2007; Durik, Vida, & Eccles, 2006; Fredricks & Eccles, 2005; Marsh et al., 2007; Sabiston & Crocker, 2008; Simpkins et al., 2006). Because males tend to have higher internal math values that females (Dai, 2001), females are less likely than males to choose STEM careers. For high school students, academic values influence their academic success after high school (Wood et al., 2011).

Internal academic values (i.e., the feelings, perceptions, and beliefs about academic-related activities, issues, and decisions) are influenced by external academic values (Creasy
Fowler, 2010). External values (i.e., an individual’s beliefs about she/he is perceived by others) impact people’s own values. The three most influential external influences on students’ academic success are parents, teachers, and peers (Gallagher, 1996). Parents are a fundamental influence in their children’s academic values and achievement (e.g., Adamuti-Trache & Andres, 2008; Davis-Kean, 2005; Gniewosz, & Noack, 2012). Parents’ perceptions and beliefs about their children’s abilities strongly influence their children’s own perceived STEM abilities and interests and career choice (Adamuti-Trache & Andres, 2008; Bleeker & Jacobs, 2004; Fredricks & Eccles, 2002, 2005; Kahn et al., 2008; Meece et al., 2006; Wood et al., 2011). Teachers also play an essential role in the success of students’ math education and ultimately on their career choice (Lee & Ginsburg, 2009).

Some of the most common factors considered by people when choosing a career are: personal and academic values, job security, pay, and external influences from parents, teachers, and peers (Sonnert, 2009). Females tend to prefer careers that involve working with people, while males prefer careers working with things (Lippa, 1998, 2006). Males tend to put their own needs ahead of other people’s needs (i.e., less altruistic), while females show more interest than males in giving back to the community, and ascribing to the precept that they have a social duty to look for the wellbeing of all its citizens (i.e., more altruistic) (Ferriman, 2008; Johnson & Bouchard, 2007).
Statement of the Purpose

The purpose of this study was to examine high school students’ values about math, perceived math achievement, and STEM career choice.

There are thirteen hypotheses examined in this study. The hypotheses are grouped in two categories: 1) math values and perceived math achievement and 2) altruistic career considerations. Each hypothesis was looked at by math self-rating, gender, and race/ethnicity. Three categorical values were used in the analysis of each hypothesis.

Hypotheses

Math values and perceived math achievement

1. No relationship exists between internal math values and perceived math achievement in high school students.
2. No relationship exists between external math values and perceived math achievement in high school students.
3. No relationship exists between external and internal math values in high school students.
4. No relationship exists between negative math values and perceived math achievement in high school students.

Altruistic career considerations

5. No relationship exists between perceived math achievement and altruistic career values in high school students.
6. No relationship exists between internal math values and altruistic career values of high school students.
7. No relationship exists between external math values and altruistic career values of high school students.
8. No relationship exists between altruistic career values and math-as-less-altruistic career values of high school students.

9. No relationship exists between negative math values and altruistic career values of high school students.

10. No relationship exists between perceived math achievement and math-as-less-altruistic career values in high school students.

11. No relationship exists between negative math values and math-as-less-altruistic career values and perceived math achievement in high school students.

12. No relationship exists between internal math values and math-as-less-altruistic career values in high school students.

13. No relationship exists between external math values and math-as-less-altruistic career values in high school students.

Assumptions

1. The “To Do or Not to Do:” Science, Technology, Engineering, Mathematics survey is a valid and reliable tool for evaluating the students’ values about math, perceived math achievement, and considerations of a career in STEM and altruistic career values.

2. Participants had an adequate reading comprehension to complete the survey.

3. Students gave an honest and accurate response to the survey.

Delimitations

1. Participants were current Washington high school general students.

2. The survey’s scores are delimited to the ability and desire of students to respond accurately and honestly to the questions.
Terminology

**Altruistic career values** Feelings, perceptions, and beliefs of a selfless nature related to career interests/choice. In other words, to take into consideration the wellbeing of others, of society, and/or of the environment with regards to career choice/interests.

**External math values** An individual’s feelings, perceptions, and beliefs about other people’s math values as they relate to that individual. In other words, the math values an individual perceives others hold about her/him.

**Internal math values** An individual’s feelings, perception, and beliefs about mathematics.

**Latino**¹ From *Amerique Latine*, a term created by the French to distinguish non-Anglo America (French, Spanish, Portuguese America into a single unit) from Anglo-America (Garcia, 2000).

**Math-as-a-less-altruistic-career** The perception that math-related careers have inherently less altruistic qualities than non-math-related careers.

**STEM** An acronym for disciplines of science, technology, engineering, and mathematics.

**Underrepresented populations** Refers to ethnic/racial minorities (e.g., African Americans, Latinos, Native Americans) and females in male-dominated fields.

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¹ For the sake of simplicity and as personal preference, I have chosen to use the term *Latino* as opposed to *Hispanic* in this study. The term *Hispanic*, from *Hispania* (Roman Empire name to designate the Iberian Peninsula), was designated in the 1970’s to quantify Spanish-speaking populations for the U.S. Census. “Contrary to claims sometimes voiced in the U.S., Hispanic was not created by the American Census bureaucracy in the 1970’s although it is true that the Census did not officially adopt it until that time” (Garcia, 2000). The term *Latino* was created by the French, *Amerique Latine*, to distinguish non-Anglo America (French, Spanish, Portuguese America into a single unit) from Anglo-America although generally the French living in North America and the West Indies have come to be excluded from the category (Garcia, 2000). Although there are preferences in favor and against for using either term, *Hispanic* and *Latino* are also used interchangeably by many. Some shared elements among Hispanic/Latinos: common language, common group identity, sense of community, and vision of family values; some differences: place of origin, (reasons for) immigration, number of generations living in the U.S., sizes of population, educational and economic attainment. For more detail see Torres (2004).
Significance of the Study

This study has both theoretical and practical significance. Theoretically, it contributes to the literature in an area of critical importance. Evaluating high school students’ values about math, perceived math achievement, and considerations of a STEM career will provide direction for future research. The practical significance of this study strives in obtaining a clearer picture of students’ self-perception as it relates to STEM attitudes and beliefs, and their influence in career choice. This study has the potential to provide insights about underlying practices that may both positively or negatively affect STEM recruitment and retention. The results of this study are expected to provide information that will allow for the improvement of assessment tools, a better framing of potential challenges, and in the future design of more effective pedagogical approaches. A better understanding of how students perceive their academic interests and abilities will better position parents and teachers to implement more efficient strategies that result in more positive math and science values, better decisions with regards to math and science coursework in high school, better achievement, and ultimately broader career options and better informed decisions. A better understanding of the issues of underrepresentation in STEM is important in order to better understand the needs of all students and provide all students with an education that will put them in a position to succeed.
CHAPTER TWO

Review of Literature

Purpose of the Study

The purpose of this study is to examine high school students’ values about math, perceived math achievement, and STEM career choice.

Introduction

The purpose of this review is to provide a background for this study by contextualizing: 1) the demand for STEM-skilled professionals in the United States at the crossroads of pivotal demographic changes as well as educational and economic challenges; and 2) some of the research on academic achievement since the middle of the 20th century. More specifically, first this review states the importance of the successful recruitment to and retention in the STEM disciplines of women and underrepresented racial/ethnic minorities, as well as men in general. Second, this review presents a synopsis of research on academic achievement examining gender and race/ethnicity from early schooling on to career choice. In sum, this review highlights the importance of high school and earlier grades in addressing the current need for a talented workforce in order to undertake the challenges of tomorrow.

The Need for STEM: Demand and Supply. Demographics: Educational and Economic Challenges

The importance of science, technology, engineering, and math (STEM) to the economic development and prosperity of the United States has been widely acknowledged (e.g., ESA, 2011; He, 2007; Legewie & DiPetre, 2011; Lindholm-Leary & Borsato, 2003; Oliver, 2011a,
There is a need for better educational achievement in order to secure the national economic wellbeing (e.g., Board on Science Education, 2011; Emdin, 2011; Lauriski-Karriker, Forssen, & Moskal, 2011). The demand for STEM skills, however, is greater than the current supply; more people are needed in STEM (Gunderson et al., 2012; Oliver, 2011b; Patrick et al., 2009). Furthermore, populations that can naturally provide the much needed demand for STEM jobs are not being optimally engaged (Board on Science Education, 2011; Gallagher, 1996).

**U.S. Demographics: The Educational Attainment Gap and the Underrepresentation of Racial/Ethnic Minorities in STEM**

The U.S. population is increasingly more heterogeneous as racial/ethnic minorities comprise a greater percentage of the total population (Girves, Zepeda, & Gwathmey, 2005; Gregory, 2003; Lane, 2001; Lindholm-Leary & Borsato, 2003; U.S. Census Bureau, 2000). Humes, Jones, and Ramirez (2011) reported that ethnic/racial minorities are the majority in Texas (55%), California (60%), New Mexico (60%), Washington D.C. (65%), and Hawaii (77%). In 2010, in 348 of the 3,143 counties in the United States at least half of the population was racial/ethnic minority. A salient fact important to consider for this study is that Latinos have become the largest racial/ethnic minority group in the Nation. In 2010, Latinos in the U.S. composed 16% of the population due to a 43% increase among Latinos. Furthermore, it is expected that by 2050, minority groups will become the majority (Girves et al., 2005).

Racial/ethnic minorities are projected to double their representation in the U.S. workforce in the next 30 years, accounting for almost half of the workforce (Committee on Equal Opportunities in Science and Engineering [CEOSE], 2000). In a report, the Business-Higher
Education Forum estimated that by 2028 “there will be 19 million more jobs than workers to fill them; roughly 40% of the people available to fill these jobs will be the members of minority groups” (Business-Higher Education Forum [BHEF], 2002, p.14). They also stated that the skills needed for the majority of these jobs require more than a high school education. Because the current and foreseeable supply is not meeting the human resources demand in the STEM fields and the increase in the racial/ethnic minority population, it is essential to strengthen recruitment and retention efforts of underrepresented groups, especially in the science and engineering fields (Wylie et al., 2007).

The growth of underrepresented groups’ general population suggests that minority groups could eventually increase their representation in the educational system from the primary grades to graduate studies and careers, naturally contributing to the national educational and career pipeline especially in the much needed areas of STEM. In many urban schools, racial/ethnic minority students already are the majority of the student population (Yates & Ortiz as cited in Roberts & Bryant, 2011). As an example, the number of Latinos, the fastest-growing minority group, in colleges will continue to grow, and their undergraduate enrollment will increase in the U.S. by one million by 2015, accounting for 15% of the country’s college population (Gregory, 2003; Lane, 2001). There is still, however, a large educational attainment gap between racial/ethnic minorities and non-minorities (Gregory, 2003; Lane, 2001; Nora, 2004; Torres, 2004). Latinos and African American students have lower academic achievement than Caucasian and Asian students from early childhood up until college (Denton & West as cited in Lee & Ginsburg, 2009; Fry, 2003; Guyll, Madon, Prieto, & Scherr, 2010; Llagas & Snyder, 2003; Verdugo, 2006). This educational attainment gap results in the underrepresentation of racial/ethnic minorities in higher education, especially in STEM.
Questions still remain about whether barriers in the pipeline may prevent these growing sectors of the population from contributing to the needed workforce, particularly in the development and innovation in the STEM fields which are essential for both the U.S. competitiveness in the global economy and a better quality of life for all its citizens. Research on racial/ethnic minorities has shown that school environments that fail to recognize their cultural and racial heritage tend to drive them away from school (Meece et al., 2006; Spencer, Swanson, & Cunningham, 1992). In a study of racial/ethnic minority males, for example, Wood et al. (2011) found that values influenced by perceptions of racial barriers have a negative impact on later postsecondary progress.

Some programs have been successful in improving retention rates of students. Barlow and Villarejo (2004) found a biology undergraduate program at a university in California (1988-1994) to be successful in increasing retention rates, success rates in math and science classes, and the likelihood of graduating of underrepresented minority students compared to students who did not participate in the program. Some features that have been found in successful recruitment and retention programs are: 1) strong support base, 2) flexibility and adaptability, and 3) overcoming barriers to reach racial/ethnic minorities (Knight & Cunningham as cited in Ketcham, Freehill, & Jesser-Cannavale, 2005).

Because these programs have usually targeted already successful students (Landgraf, Peters, & Salmon-Stephens, 2008), some researchers (e.g., Blickenstaff, 2005) have argued that many of those efforts have not worked or have not been sufficient. Colleges and universities have recently changed their recruitment strategies in order to obtain better recruiting outcomes by targeting students who are not typically identified as interested in science and math, or who are not the highest achieving students in terms of math scores (Landgraf et al., 2008). The high
school years have been found to be a critical stage as high school students’ academic values influence their post-secondary academic success (Wood et al., 2011). In a study examining students’ persistence in science, Smyth and McArdle (2004) found that at selective institutions prior academic preparation explained the gap in persistence rates between Asians (with the highest persistence rates) and Caucasians and the lower rates of some underrepresented groups (i.e., Native Americans, Latinos, African Americans).

The Underrepresentation of Women in STEM: Barriers to Advancement

In addition to the underrepresentation of racial/ethnic minorities, women have also been historically underrepresented in STEM (Board on Science Education, 2011; Cole & Espinoza, 2008; Graham & Smith, 2005; Lindholm-Leary & Borsato, 2003; National Center for Education Statistics, 2001; National Science Board, 2012; Patrick et al., 2009; Ramirez & Wotipka, 2001). Scholars have been interested in the issue of the underrepresentation of women in engineering and the sciences (Blickenstaff, 2005; Ketcham et al., 2005). “Male students are typically overrepresented in STEM majors…even as the percentage of female students in higher education has exceeded that of their male counterparts” (Cole & Espinoza, 2008, p. 298). It has been observed that the low representation of women in the STEM disciplines worsens the farther along the pipeline (e.g., Cronin & Roger, 1999; Rosser, 2004). Rosser (2004) argued that a statement made by the leaders of some of the nation’s most prestigious universities (i.e., Cal Tech, Harvard, MIT, Michigan, Princeton, Stanford, UC-Berkeley, U-Penn, Yale) in 2001, suggested that “institutional barriers have prevented women from having a level playing field and that science and engineering might need to change” in order to address this issue (p. 50).
Some researchers argue that women and other underrepresented groups still encounter prejudice and discrimination in higher education that form barriers to academic success (e.g., Frierson, 1990; Gregory & Tillman, 2003; Myers & Turner, 2004). Many have argued that, although there is not a systematic effort to consciously “filter women out,” there are many factors that when combined have a cumulative effect, resulting in gender disparity (Blickenstaff, 2005).

*Environmental factors that affect women’s persistence in STEM fields*

There are external factors that may have an effect in women’s advancement in STEM. The environment in science and engineering needs to be further examined (Brainard & Carlin, 1997). “Some women scientists actively choose to avoid research universities…because of the hostile climate” (Roser, 2004, p. 54). The STEM disciplines have been traditionally male-dominated fields (Bix, 2004; Chesler & Chesler, 2002; Faulkner, 2000; Landgraf et al., 2008). That the STEM fields are predominantly male-centered is reflected not only by the numerical overrepresentation of men, but also in the traditions, practices, and departmental cultures that present institutional barriers for women (Rosser). Based on Valian’s research, Wylie et al. (2007) pointed that a traditionally male-dominated environment can cause internal conflict for women who persist in fields that conventional stereotypes rule out as inaccessible or inappropriate for them, and generate patterns of self-selection out of these fields. For example, Brainard and Carlin observed that isolation was a common concern for all female science and engineering students from their sophomore year on.

In their study about mission statements of 20 engineering and liberal arts schools, de Pillis and de Pillis (2008) suggested that a profoundly ingrained culture of masculinity and
hierarchy in engineering may be a factor of why engineering schools might be having trouble attracting a more diverse group of students. They found that engineering students showed a significantly more masculine and authoritarian character (i.e., more likely to be dominant, forceful, and masculine; less likely to defend their beliefs, be soft spoken, eager to soothe feelings, feminine, or likable). Among males, unlike for their female counterparts, there was a positive relationship between the likelihood to indicate that a successful student at an engineering institution was someone like themselves and their level of authoritarianism. This culture of masculinity and hierarchy could logically play a role in the environment women face in engineering and perhaps other fields in which women are still underrepresented even when today women are completing graduate science training in record numbers (Wylie et al., 2007). It is important to note that what is considered ‘masculine’ is often taken to be of higher status than what is regarded as ‘feminine’ (Adam, Howcroft, & Richardson, 2004). Professions that become predominantly ‘female’ or ‘feminized’ tend to lose prestige/status and earn lower salaries as a result of men moving from those fields to other areas (e.g., Armenti, 2004b).

Some have noted that discrepancies observed with respect to women’s motivation and achievement could be even more marked in those who, in addition to gender bias, have to deal with racial/ethnic bias, affecting even more the recruitment and retention issues of underrepresented populations in STEM (Gonzalez, 2006; Guyll, Madon, Prieto, & Scherr, 2010; Lim & Li, 2006; Spencer, Swanson, & Cunningham, 1992; Steele, 1996; Wylie et al., 2007). In a study (Gonzalez, 2006) focused on Latina doctorates, for example, many women indicated being told, directly or indirectly, that they needed to work twice as hard and be twice as good to survive in their doctoral programs. These women reported experiences as teaching assistants in which their authority was challenged, particularly in courses that dealt with diversity, and feeling
disrespected and in need to constantly prove themselves. They also experienced difficulties with professors and in their writing, and cultural dissonance and isolation as they were caught between sometimes conflicting pressures as a result of their responsibilities to their families (e.g., caring for parents, children, partners, and siblings) and their communities, and the academy (Gonzalez, 2006).

* A problem of self-perception and lack of confidence?

While some researchers argue that women and other underrepresented groups still encounter prejudice and discrimination in higher education that form barriers to academic success (Frierson, 1990; Gregory & Tillman, 2003; Myers & Turner, 2004), some questions arise in the STEM disciplines as to whether women face discrimination or rather actively choose different career paths. According to some researchers, the difficulties faced by women in STEM appear to be an issue of self-perception in science and math (Brainard & Carlin, 1997; Cole & Espinoza, 2008; Ermer, 2004; McIlwee & Robinson, 1992). For example, in their longitudinal study on undergraduate women in engineering and science, Brainard and Carlin found no significant difference in academic achievement (measured by GPA) between women who persisted and women who changed to non-engineering or non-science majors. Women were more likely to switch out of engineering and science in the first two years of their program due primarily to a combination of factors (i.e., losing interest in the field, being attracted by another field, being discouraged by academic difficulties and low grades). This seems to coincide with results of other studies (e.g., Thom as cited in Ermer, 2004).

One of the most frequently perceived barriers for first-year students and sophomores was lack of confidence (Brainard & Carlin, 1997). The percentage of students who identified low
confidence as a barrier to their persistence in their science or engineering major more than doubled by their senior year. They observed differences in academic confidence for those students who switched during their sophomore or junior years. Science as well as math confidence were significantly lower for the women who switched to non-engineering or non-science majors in their sophomore year than for those who stayed. Science confidence was significantly lower for those who switched during their junior and senior years whereas math confidence was equal to those who stayed. The overall trend was a decline in academic confidence from their first year. For those who persisted, even when their confidence levels improved, they never reached the levels observed in their first year. Those who were most likely to persist through the first year chose to pursue their major primarily because of enjoyment of science and math classes (in high school and college), their ability to work on their own, and the awareness of career opportunities in science and engineering. In addition, they perceived a positive influence from faculty in their first undergraduate year. Two of the primary factors in persisting in engineering and science in the sophomore year were continued enjoyment of courses and a positive relationship with an advisor. In the junior year, other factors that also influenced persistence were relationship with a mentor, experiences in student societies and conferences. In the senior year, all these factors continued to play a role. It is important to note that even women who chose to stay often perceived barriers to persistence at each stage of their education. The perceived barriers of those who stayed coincided with the reasons to leave for those who decided to switch out of engineering or science. Some of the concerns that seemed to increase dramatically by the senior year were lack of interest, poor advising, and feeling intimidated. Cole and Espinoza (2008) argued that promoting female students’ self-concept in STEM-related courses would increase their academic performance. Perhaps the academic
environment and the socialization process, combined with demographic inertia (Marschke et al., 2007) are not conducive to the healthy development of women’s self-perception in these majors. Low self-perception regarding science or math ability may have a negative effect that perpetuates and may even intensify throughout their career (Nosek & Smyth, 2011; Wylie et al., 2007).

To be or not to be, the dilemma between family and a STEM career

Although females are less likely to enter science and engineering majors, once in college, it appears that women in science and engineering tend to do better academically, have higher degree completion rates (49% compared to 40%), and are less likely to switch majors (11% compared to 19%) than their male counterparts (Huang, Tadde, & Walter, 2000). These findings seem to suggest that in general, and against some prevailing stereotypes, women who enter science and engineering programs tend to be adequately prepared and perform well (Cole & Espinoza, 2008). Yet, while the women recruited to the STEM disciplines generally perform well, the numbers who actually choose these majors are limited. Women faculty attrition rates, for example, are higher than men’s, especially in the sciences (Preston as cited in Wylie et al., 2007).

One of the difficulties that seem to affect many women’s career choice is the conflict that having children poses in the context of an unsupportive environment that assumes a male model (Grant, Kennelly, & Ward, 2000; Wylie et al., 2007). Balancing work and family responsibilities has been found to be the major issue for women in the STEM disciplines (Rosser, 2004). Women spend significantly more time than males in caring for their children and in household responsibilities (Sax, Hagedorn, Arredondo, & Dicrisi, 2002). Women more so than men often
encounter themselves in a dilemma in which they are forced to choose between family and work without the option of balancing the personal and professional aspects of their lives (Ahuja, 2002; Armenti, 2004a). “It is difficult to simultaneously achieve career success while making and meeting commitments to family” (Drago as cited in Wylie et al., p. 6).

*A pipeline with a dead end: Does female underrepresentation in STEM faculties and adverse conditions cause women to select out?*

The successful recruitment and retention of women and racial/ethnic minorities into STEM is important to further recruit and retain new generations of students. Students from underrepresented groups greatly benefit from same sex and same race/ethnicity role models and mentors. The percentages of women faculty, for example, have been found to be positively associated with the percentages of women undergraduate students in math (Sharpe & Sonnert as cited in Fox, 2008), engineering and science (Canes & Rosen, 1995), and in life and physical sciences (Sonnert, Fox, & Adkins, 2007). But if the situation women encounter in their higher education and early career experiences is so dire, then it is no surprise that women “select out of STEM at a greater rate than men” (Lauriski-Karriker et al., 2011, p. 1).

The recruitment and retention of underrepresented groups, including women particularly in science and engineering, remains one of the most prevailing issues facing U.S. higher education (Fox, 2008; Turner, 2000). According to Wylie et al. (2007), in the STEM disciplines, women have been awarded at least 25% of the Ph.D.’s since 1970, yet their representation among full professors is still less than 10%. Although some have claimed that gender parity will be reached in the STEM fields as women advance through the ranks, “other information indicates that more substantial changes must occur to make the climate more female friendly to
retain senior women in science and engineering” (Rosser, 2004, p. 54). Marschke, Laursen, Nielsen, and Rankin (2007) concluded that, under current conditions gender parity will never be reached and that even to match the current rate of Ph.D. candidate pools (about 40% across fields) would take at least 25 years (Wylie et al., 2007).

The recruitment of women to STEM is no easy task. Kelly (2006) argued that inadequate recruiting techniques result in small applicant pools and few qualified candidates to choose from thus contributing to the difficulty of recruiting women to STEM disciplines. Litt and Debinski (2004) noted that their university was not hiring, retaining, or promoting women faculty at the same rate as men, exemplifying a national trend of precarious concern for many universities that are struggling to recruit and retain female students and faculty in the STEM disciplines. They argued that faculty attrition is a costly process for their institution, that it detracts from the institution’s educational mission, and that it limits the procurement of research grants and the development of collaboration in research. A public U.S. college of engineering established a program which offers awards to search committees of its departments to develop innovative and proactive recruiting strategies with a focus on diversity (Kelly, 2006). A dean of the institution stated the need to change the mind-set about recruiting by being more proactive and creative in advertising positions to increase the pool of applicants. Departments in this institution that have taken advantage of the awards have used them to fund faculty and department heads to travel to professional meetings and conferences (e.g., NSF-sponsored workshop for female engineers interested in faculty positions, the annual American Institute of Chemical Engineers meeting) and other institutions where they advertise and talk individually to graduate students and postdocs about openings and emphasize student excellence, research expertise, interdisciplinary research projects, resources that support teaching, internal funding opportunities, university
policies on family and medical leave, and dual-career assistance. Funds have also been used to advertise openings in various media (e.g., listservs, professional magazines, publications, websites). As a result of the implementation of these strategies, twice as many female applicants and almost five times as many overall applicants was accomplished during the most recent previous search in one department. Many candidates identified personal contact as one of the key factors in applying for the position. Given that the departmental culture may influence a female candidate’s decision to accept or reject a position, the college of engineering of that institution introduces female candidates to female faculty already in the department as well as to other women on campus and to campus-wide resources available to them.

Recruiting and retaining females to STEM in college, middle school and high school

Blickenstaff (2005) argued that there are three compelling reasons to counter the claim that general success in technical fields is evidence that there is nothing wrong with the way things are now: 1) people should be able to study and work in whatever field they decide; 2) women who have the potential to make significant contributions may not be getting a fair chance to choose to enter one of the STEM disciplines; and 3) a greater diversity of perspectives can only strengthen problem solving and innovation. Many programs have been established over the past decades to encourage the participation of females in STEM (e.g., see Ermer, 2004; Kelly, 2006; Ketcham et al., 2005; Sonnert & Holton, 1995). Many non-governmental organizations and federal agencies provide career information, grants, networking, mentoring, and research on women in science, and support programs for girls and young women from higher education to elementary school (De Welde et al., 2007). For example, NSF’s ADVANCE programs provide funding to universities across the nation for projects that seek to implement institutional
transformations in reducing gender disparities by: increasing women’s representation on STEM faculties and campus administration; collecting data; reviewing policies; supporting women’s research and leadership development; and focusing on more equitable hiring practices, women’s retention, and the academic climate (De Welde et al.).

Programs that have been successful in the recruitment and retention of female students have been characterized by: 1) providing a strong support base, 2) being highly adaptable, and 3) overcoming barriers to reach women (Knight & Cunningham as cited in Ketcham et al., 2005). One college’s approach to increasing the number of women pursuing STEM careers was to establish the first engineering program at an all-women’s college in 1999, graduating its first all-female class of engineers in May 2004 (Ketcham et al., 2005). This program is well-known for its core in the humanities and rigorous, thorough requirements. According to the founding director of the program, engineering is using science and math for the service of humanity.

Many universities have outreach programs to encourage and attract females to the STEM disciplines and provide training to school teachers. As an example, one institution has several outreach programs targeted at girls and young women of different ages and school grades (Landgraf et al., 2008). This university has a Women Engineers Career day since the early 1990’s to introduce high school female students to engineering professions. Some programs are weekend events for girls between the ages of 13 and 17 (grades 9-12) to introduce them to the process of engineering design and engineering careers. Other programs comprise week-long engineering and STEM-related activities and workshops for middle and high school female students. In addition, other outreach programs provided in an irregular basis are tool workshops, visits to schools, and luncheons with prospective students. Some programs are more focused towards middle school (grades 7-9) female students. Although the majority of these programs
have had relative success and have been rated positively by participants, some have been either done only once or eliminated after some time due to decreasing enrollment and lack of funds.

Some programs have shown a positive impact. One university gives age-specific summer camps for girls interested in engineering with approximately 25% of the female participants in the 10th and 11th grades enrolling to that institution (Zurn-Birkheimer & Holloway as cited in Landgraf et al., 2008). Another university also uses the approach of summer and academic year programs with small groups (25-40 participants) to ensure personal contact and narrow age-groups (e.g., girls grades 7-8, grades 9-10, grades 11-12) and age-appropriate topics and activities with considerably good success (overall 60% of participants subsequently enroll at the institution) (Elmore & Guess as cited in Landgraf et al.). This approach keeps participants connected to STEM and to women in the institution’s STEM programs until they choose what institution they will attend and in what area they will major in. Mentoring programs also provide positive support networks for females in male-dominated fields (Goodman Research Group, 2002) and have been shown to increase retention (National Science Foundation, 2007).

Some researchers (e.g., Blickenstaff, 2005) have argued, however, that many of those programs have not been effective or sufficient. One of the reasons is that most of these programs have been directed at already highly successful students (Landgraf et al., 2008). As a result, many colleges and universities have recently changed their recruitment strategies in order to obtain better recruiting outcomes by targeting students who are not typically identified as interested in science and math, or who are not the highest achieving students in terms of math scores (Landgraf et al.). Furthermore, Gallagher (1996) argued that from early on, girls are faced with barriers to math independence which accumulate and compound over time.
Thus, some universities have also opted to promote their STEM programs and careers to younger students (Baker, Rieg, & Clendaniel, 2006; BSE, 2011; Hart, 2010; Lauriski-Karriker et al., 2011; Sorby & Schumaker-Chadde, 2007), implying that establishing sustained longer-term relationships with students even from an earlier age could provide better recruitment and retention results (Landgraf et al.; National Academy of Engineering, 2008). Many such programs have had substantial success (Ferrante, 2012; National Science Foundation, 2012a). There is even an example of a state government that several years ago introduced a required pre-engineering content in primary school (Ermer, 2004).

Despite efforts to deal with the issue of women underrepresentation in STEM and improvements in the last few decades, the situation still persists and appears far from resolved. Although women have greatly increased their representation in almost all areas of undergraduate and graduate education since 1972 legislation (Title IX) prohibiting sex discrimination in education, they continue to lag behind in the STEM disciplines (Wylie et al., 2007). Furthermore, even when the representation of women in the STEM disciplines has increased considerably in the last few decades (e.g., Gallagher, 1996; National Science Foundation as cited in De Welde et al., 2007), women are still concentrated only in certain fields such as biology and health-related professions, and most professions continue to be sex-segregated (De Welde et al.). In 2006, the percentage of women freshmen who intended to major in science and engineering fields nation-wide, excluding the social/behavioral sciences, was just 15% (10% in biological and agricultural sciences; 2% in engineering; 2% in physical sciences; 0.6% in math/statistics; 0.4% in computer sciences) compared to 29% of men (14% in engineering; 8% in biological and agricultural sciences; 3% in computer sciences; 3% in physical sciences; 1% in math/statistics) (National Science Foundation, n.d.). For the 405,489 undergraduates enrolled in engineering
programs in 2006, only 17% (69,869) were women (National Science Foundation, n.d.). Of first year students enrolled full time, only 17% were female.

These enrollment percentages for undergraduate women are below those for 1994 (19%) and the graduation rates are even lower than the 16% of bachelor’s degrees in engineering in the late 1990’s (Babco as cited in Brainard & Carlin, 1997) and 21% in 2002 (Ermer, 2004) for example. Even as the enrollment of female engineering students increased in the past decades, retention rates had decreased (Brainard & Carlin, 1997). The national retention rate for women engineering students peaked at about 90% in the 1970’s and went down to less than 60% in the 1980’s-mid 1990’s. In 1991, for example, the retention rate for female engineering students at a research university was at approximately 55% (Brainard & Carlin). Despite some improvements in the last decade, graduation rates in engineering have lagged behind other areas that have seen much higher increments such as medicine (42%) and law (45%) (Ermer, 2004). At one university, in 2008, only 14% of the engineering and architecture degrees at the undergraduate level went to women. From the data available in that institution, less than 5% of the undergraduate degrees were awarded to women in mechanical engineering, for example. Though female enrollment in universities increased from 43% in the 1970’s to 63% by the mid 1990’s, 70% of females enrolled in science and engineering were switching to other majors during the last decade of the century (Owens, Smothers, & Love, 2003).

Although females face barriers in math achievement from early on in their academic development, which accumulate over time (Gallagher, 1996), the high school years have been found to be a critical stage as high school students’ academic values influence their post-secondary academic success (Adamuti-Trache & Andres, 2008; Wood et al., 2011). Even though females are just as likely as males to enroll in math and science advanced courses in high school,
males are more likely than females to report that they like those classes (National Center for Education Statistics as cited in Meece et al., 2006). Furthermore, a study examining students’ persistence in science (Smyth & McArdle, 2004) found that prior academic preparation explained the gender gap in persistence rates. There seems to be a consistent pattern of a lower percentage of women graduating than those who initially enrolled and, in engineering specifically, the very few that enter drop out at higher rates than men (Ermer, 2004).

It is likely that external factors such as unsupportive academic environments and stereotyped societal expectations may hinder the development of females’ STEM self-perceptions. Research suggests that perceived ability and academic interests (internal math values) are important predictors of academic engagement and achievement in general as well as in math and science, particularly in high school (Austin, 1990; Baker & Wigfield, 1999; Durik, Vida, & Eccles, 2006; Eccles, Jacobs, & Harold, 1990; Fredricks & Eccles, 2005; Marsh et al., 2007; Sabiston & Crocker, 2008; Simpkins et al., 2006; Updegraaff, Eccles, Barber, & O’Brien, 1996). Low perceived math ability may have a negative effect that continues and may even intensify throughout females’ careers (Wylie et al., 2007).

The Underrepresentation of Men?

The emphasis on the recruitment of women to STEM fields in the last few decades has resulted in an increase of female participation in STEM, though not necessarily at an optimal pace (Meece et al., 2006). Hyde (2005), however, argued that popular media have exaggerated gender differences and reinforced gender stereotypes harmful for females as well as ignored areas where males are underachieving (Meece et al., 2006).
Thus, attention must be drawn to the grim situation of males as well, as fewer males pursue a university/college career (Blue et al., 2005; Hoff-Sommers, 2000; Roenigk, 2011; Tabarrok, 2012). Recent studies on high school students have shown that math and science achievement gaps have diminished and, in some cases, have even been eliminated (Meece et al., 2006; NCES, 2004). The gap in math has narrowed, however, because male students’ perceived math ability has declined faster than girls’ (Dotterer, McHale, & Crouter, 2009; Jacobs et al., 2002). There is some indication that by 12th grade, females’ perceived math ability is generally higher than that of males (Dotterer et al., 2009). Males’ academic interest may decline faster than females’ due to a possible incongruence between styles of learning and the style of teaching employed by secondary school teachers (Dotterer et al.). Though females’ perceived ability has been cause for alarm, Jacobs et al. (2002) pointed out that males’ situation is as startling. Males’ lack of perceived math ability, achievement, and interest makes them more vulnerable to dropout out of school or select a different field. Males comprise only 43% of the college population, a level below that of the mid 1980’s (48%), and their representation in college is expected to decrease (Gerald & Hussar as cited in Jacobs et al., 2002).

Hoff Sommers (2000) reported male student are generally less academically engaged and less likely to attend college than their female counterparts. Further, she argued that, compared to males, females have better academic achievement and higher expectations. Males are more likely to fail because they are being overlooked resulting in disengagement from school. As an example, in a survey a greater percentage of male students (31%) expressed that their teachers did not listen to them, causing them to be pessimistic (see Hoff Sommers). Whereas students with positive academic values tend to be more persistent and more interested, perform better, and feel that teachers care about them, students with low academic values (70% of which are
reported to be male) tend to have low expectations and poor achievement (Hoff Sommers). Jacobs et al. (2002) argued that males lag behind females in academic achievement (e.g., Marsh & Yeung, 1998). Perhaps it is time to focus on males’ declining academic values while at the same time not neglect female students (Dotterer et al., 2009). The scenario of a smaller-than-needed workforce pool worsens as fewer qualified men are seeking college education (Blue et al., 2005, Hoff-Sommers, 2000; Roenigk, 2011; Tabarrok, 2012) and are opting to go into the trade occupations and even fewer men are going into the STEM disciplines and graduate school (Blue et al.). This will disproportionately affect the STEM disciplines, as few females currently choose the STEM fields. In general, 40% of U.S. STEM first year students switch majors and more non-STEM majors graduate than STEM majors (Weiford, 2012).

Achievement Motivation: From Personality Disposition to an Inclusion of External Influences.

Educational Success: From Elementary School to High School

Around the middle of the 20th century (i.e., 1950’s to 1970’s), achievement motivation was considered to be based on personality characteristics acquired early on in an individual’s development and staying pretty much constant over time without much outside influence (Meece et al., 2006). The understanding and the research at the time resulted in the conception that women were afraid of or not oriented towards success. To this vision of personality dispositions, cognitive assessments such as an individual’s motives, success expectations, and expected outcomes were added (see Atkinson, 1957, 1964). According to research in the 1960’s, females were found to have lower expectations for success than males (Meece et al., 2006). In the 1970’s, however, many researchers stated that such a conception of achievement motivation was biased against women (Meece et al., 2006; see also Eccles, 1994; Frieze, Parsons, Johnson, Ruble, & Zellman, 1978).
Successful and Failure: Math Ability and Effort

Attribution theories, which emerged to prominence in the 1970’s and early 1980’s, emphasize how individuals perceive and interpret success and failure (Meece et al., 2006). According to attribution theories, special importance to an individual’s perception of success is given to ability and effort (Weiner as cited in Meece et al., 2006). Early studies using the attribution framework found that females tended to have lower expectations of success than males (Meece et al., 2006). When it comes to perceptions of success, research showed that males credited success to ability, but females did not while identifying a lack of ability as the reason for failure (Bar Tal, 1978; Crandall, Kathkovsky, & Crandall, 1965; Frieze, 1975; Meece et al., 2006). Furthermore, Burgner and Hewstone (1993) found attributional differences by gender in six years old and younger.

In math, as well as in science, males are more likely to ascribe their success to ability than females are (Beghetto, 2007; Jovanovic & King, 1998; Meece et al., 2006). It is possible that some gender differences may already exist in the elementary school years (Andre, Whigham, Hendrickson, & Chambers, 1999; Licht, Stader, & Swenson, 1989). In turn, females are more likely to ascribe success to effort and hard work, and failure more to lack of ability (e.g., Burgner & Hewstone, 1993; Davies & Brember, 1999; Dweck, Davidson, Nelson, & Enna, 1978; Furnham & Rawles, 1995; Georgiou, Panayiotis, & Kalavana, 2007; Lightbody, Siann, Stocks & Walsh, 1996; Parsons, Meece, Adler, & Kaczala, 1982; Powers & Wagner, 1984; Ryckman & Peckham, 1986, 1987; Stipek, 1984; Stipek & Gralinski, 1991; Wolleat, Pedro, Becker, & Fennema, 1980; Yee & Eccles, 1988).

Meece et al. (2006) argued that females’ tendency to credit their success to effort may unfavorably affect their expectations for success in more difficult and advanced math classes.
(see also Eccles et al., 1983; Wolleat et al., 1980). Females may be more prone to learned helplessness (Dweck, 1986; Eccles et al., 1983; Farmer & Vispoel, 1990; Meece et al., 2006). In other words, females may be more likely to credit their failure in math to a lack of ability and thus may desist more easily when facing difficult math tasks. Several studies found that children who displayed learned helplessness underestimated their achievement and believed their peers did better than them whereas children who did not display learned helplessness persisted even in the face of failure since they ascribed failure to lack of effort rather than to lack of ability (Meece et al., 2006; see Diener and Dweck, 1978; Dweck, 1986; Dweck & Repucci, 1973). On the other hand, ascribing academic success to effort, instead of ability, has been positively associated with better academic achievement (Christenson, Rounds, & Gorney, 1992).

_Perceived math and science achievement and interest: Differences by gender_

Jacobs and Bleeker (2004) found that males tend to have higher perceived math ability than females as early as first grade. A study (Dickhäuser & Meyer, 2006) of 8 and 9 year old students found no significant gender differences in math achievement or in their ability. Females, however, were more likely to ascribe math failure to a lack of ability whereas success more to effort. Changes in perceived ability explain most of the changes in academic interest over time (Jacobs et al. 2002). Thus, perceived low ability in females in particular can result in more negative STEM values, and ultimately on achievement (e.g., Niewswandt, 2007; Nosek & Smyth, 2011; Simposon & Oliver, 1990; Welch, Walberg, & Fraser, 1986). Studies that have examined older students have also found that adolescent males tend to have higher perceived math and science ability than females (e.g., Anderman & Young, 1994; Beghetto, 2007; Cadinu, Maass, Rosabianca, & Kiesner, 2005; Campbell, 1991; Eccles, Adler, & Kaczala, 1982;

Though some studies on elementary school and middle school students (e.g., Dickhäuser & Meyer, 2006; Georgiou et al., 2007) have found no significant gender differences in math achievement or in ability by gender, others have found that males tend to have higher achievement than girls (McGraw, Lubienski & Strutchens, 2006; Nosek & Smyth, 2011; Robinson, Abbott, Berninger, Busse & Mukhopadhyay, 1997). Furthermore, some researchers (Jordan, Kaplan, Locuniak, & Ramineni, 2007) have found that, on average, differences in math ability appear early, even before formal schooling begins, and that they widen over time. In another study, Manning (1998) found that gender differences in math ability by gender emerged in the adolescent years.

Females’ interest in science and math declines from elementary school to middle school (Creasy Fowler, 2010; Eccles, Wigfield, Harold, & Blumenfeld, 1993; Fredricks & Eccles, 2002; Jacobs et al., 2002; Jacobs & Bleeker, 2004; Jacobs et al., 2002; Wigfield et al., 1997). Elementary school female and male students appear to be equally interested in science, but females’ interest declines at the beginning of middle school (Dawson, 2000; Shakeshaft, 1995) and even in the preceding years (Creasy Fowler; Dai, 2001). In high school, math and science interest continues to decline, especially for females (Haussler & Hoffmann, 2002). Females may choose to opt out of science because they do not see its relevance (Brickhouse, 2001). Students who experience frustration and a lack of interest in science and math courses may see math and science as irrelevant and thus avoid such classes and eventually drop out of school (Creasy Fowler; Lyons, 2006; Patrick et al., 2009). Furthermore, in a study of high school dropouts, 47%
of the students expressed boredom and lack of interest as a main reason for dropping out (Bridgeland, DiJulio, & Morison as cited in Dotterer et al., 2009). On the other hand, House (2003) found that students with positive math values were more likely to enjoy math. Children’s math values are major predictors of future achievement and choices such as math course enrollment (Jacobs & Bleeker, 2004; Eccles-Parsons et al., 1982; Eccles et al., 1984; Eccles & Harold, 1991). In a study on students and advanced math courses, Erickan, Mcreith, and Lapointe (2005) found that having positive math values was the strongest predictor of student interest and achievement.

*External Influences on Perceived Math Achievement: Ability and Interest*

In the 1980’s, research on perceptions of achievement incorporated the component of external influences and the role they play in an individual’s beliefs about achievement (see Eccles et al., 1983). Namely, this social component considers the role of parents and teachers, culture, and identity development (Meece et al., 2006). Two aspects of particular importance in the formation of math achievement perceptions are: 1) perceived ability (i.e., competency beliefs) and 2) interest (i.e., value beliefs).

*Perceived ability*

Research has shown that perceived ability is strongly related to academic achievement (see Eccles et al., 1983; Parsons, Adler, & Kaczala, 1984; Wigfield & Eccles, 1995; Meece et al., 2006). As early as first grade, students have shown the capacity to assess their own math ability, with males presenting higher perceived math ability than females (Anderman & Young, 1994; Eccles et al., 1993; Pintrich & DeGroot, 1990; Zimmerman & Martinez Pons, 1990). Perceived math ability decreases for all students as they advance in their schooling (Wigfield & Eccles,
Males’ perceived math ability, however, decreases faster than that of females, resulting in the narrowing of the gender gap with regards to math ability by the time they reach high school (Fredricks & Eccles, 2002; Jacobs et al., 2002).

**Interest**

Value beliefs refer to the interest an individual has in accomplishing a task (Meece et al., 2006). Research has shown that the value an individual gives to math, for example, influences that person’s enrollment and participation in elective math courses (Feather, 1988; Meece et al., 2006; Parsons et al., 1984). Though Eccles et al. (1993) found no differences by gender with regards to interest in math among elementary school students; they did find that males begin with higher perceived math achievement than females. In addition, research has shown a decrease of interest in math at the transitional period from elementary school to middle school (i.e., 7th grade) (Wigfield, Eccles, Mac Iver, & Reuman, 1991). This decrease in interest in math accelerates and continues throughout high school, regardless of gender (Fredricks & Eccles, 2002; Jacobs et al., 2002). Meece et al. (2006) suggested that a decrease in perceived ability can have an adverse effect on the value students ascribe to achievement. They advised that, in order to improve students’ motivation, it is important to address students’ perceived ability and academic interests in elementary school as well as in the following stages. Perceived ability plays an important role in predicting achievement whereas interest strongly predicts students’ academic engagement (Meece et al., 2006). Furthermore, studies have found the relationship between perceived ability and interests as early as first grade and becoming stronger with age (Eccles. 1994; Eccles et al., 1983; Meece et al., 2006; Parsons et al., 1984; Wigfield & Eccles, 1992). Meece et al. (2006) argued that, if there are gender differences with regards to perceived
ability and academic interests, those differences may impact females’ and males’ choices, engagement, and achievement.

Self-efficacy theory and academic motivation

Another theory that deals with academic motivation is self-efficacy, the belief an individual has on his/her ability to learn and achieve academic success (Meece et al., 2006). Research has shown the importance of self-efficacy beliefs with regards to course enrollment, persistence, and even career choice (Meece et al., 2006). Differences in perceived ability are believed to emerge more prominently in middle school, a stage that coincides with adolescence, when students pay more attention to gender-role expectations (see Bandura, Barbarelli, Caprara, & Pastorelli, 2001; Wigfield, Eccles, & Pintrich, 1996).

External influences on motivation in female and male students: The role of parents, teachers, and culture

External influences, such as parents and teachers, impact students’ perceived ability and academic interest by modeling and communicating expectations, and by providing encouragement (Eccles et al., 1983). In addition, research has shown that expectations predict postsecondary attainment (Mello, 2008). Parents’ perceptions and beliefs about their children’s abilities strongly influence their children’s own perceived abilities and interests, including in math and science, as well as career choice (Adamuti-Trache & Andres, 2008; Ardelt & Eccles, 2001; Bleeker & Jacobs, 2004; Eccles & Harold, 1991; Fredricks & Eccles, 2002, 2005; Frome & Eccles, 1998; Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001; Kahn, Huang, Gillman, Field, Austin, Colditz, & Frazier, 2008; Lynch, 2002; Marsh, 1993; Meece et al., 2006; Nicholls, 1979; Shumow & Lomax, 2002; Tiedemann, 2000; Wood et al., 2011). Meece et al. (2006)
argued that the role of parents becomes more important as children get older. Though the gender gap with regards to choosing to take math courses has narrowed in the past four decades, women continue to lag behind men when it comes to choosing STEM careers (see Meece et al., 2006, p. 362). Teachers’ expectations and perceptions of their students’ math abilities, in particular, have been found to be gender-biased in favor of males over females (Meece et al., 2006). For example, Fennema, Peterson, Carpenter, & Lubinski (1990) found teachers were more likely to attribute males’ success to ability, but females’ successes to effort or teacher help, even as early as first grade. Societal and cultural influences also impact students’ motivation development (Meece et al., 2006).

Rationale for a Math (External and Internal) Values Framework

Because changes in perceived academic ability explain most of the changes in academic interest over time, it is preferable to study them “together, rather than separately as they may be overestimated in isolation” (Jacobs et al., 2002). Research suggests that perceived ability and academic interests (internal academic values) are important predictors of academic engagement and achievement in general as well as in math and science in particular (Austin, 1990; Baker & Wigfield, 1999; Denissen, Zarrett, & Eccles, 2007; Durik, Vida, & Eccles, 2006; Eccles et al., 1990; Fredricks & Eccles, 2005; Marsh et al., 2007; Marsh, Köller, Trautwein, Lüdtke, & Baumert, 2005; Sabiston & Crocker, 2008; Simpkins et al., 2006; Updegraff et al., 1996). Values are composed of perceptions, beliefs, and feelings about the interest, importance, and usefulness of an activity or issue (Eccles & Wigfield, 2002). Furthermore, values have also been found to be strongly related to career choice (Patrick et al., 2009; Eccles & Wigfield, 2002). Because males tend to have higher internal math values that females (Dai, 2001), it is expected that females will be less likely than males to choose STEM careers.
Students form perceptions about math in earlier stages of academic experience (e.g., Gunderson, Ramirez, Levine, et al., 2012; Lafortune, Daniel, Fallascio, et al., 1999). Thus, from early on, positive experiences can lead to the development of positive math and science values (Helmke & van Aken, 1995; Patrick et al., 2009). Adolescents’ math values have been found to be linked to their math achievement (e.g., Creasy Fowler, 2010; Simpkins, Fredricks, & Eccles, 2012). For high school students, academic values influence their academic success after high school (Wood et al., 2011). Internal academic values (i.e., the feelings, perceptions, and beliefs about academic-related activities, issues, and decisions) are influenced by external academic values (Creasy Fowler, 2010). External values are the values an individual perceives others hold about her/him. In other words, the beliefs about how they are perceived by others (external values) impact people’s own values. The three most influential external influences on students’ academic development and success are parents, teachers, and peers (Gallagher, 1996). Students’ perceptions of the values held by their parents, peers, and teachers about them can influence their perceived achievement (Gallagher). Harter and Jackson (1992), for example, found that females’ decline in math and science interest was due to both internal and external values.

*Parents’ influence on their children’s math and science values and academic success*

Parents are a fundamental influence in their children’s academic values and achievement (Adamuti-Trache & Andres, 2008; Chen & Stevenson, 1995; Davis-Kean, 2005; Eccles, Adler, & Kaczala, 1982; Gniewosz, & Noack, 2012; Jacobs, Finken, Griffen, & Wright, 1998; Patrikakou, 1997). “Parents’ child-specific beliefs (ability perceptions, expectations of success) are suggested as being expressed in parental behaviors and communications of their beliefs, which, in turn, is assumed to affect the child’s academic outcomes” (Gniewosz, & Noack, p. 810). Gonzalez-Pienda et al. (2002) found that parents’ academic values about their children’s
ability strongly influenced their children’s internal academic values, which in turn influence achievement. Parents’ expectations of their children’s math abilities are related to their math values and achievement throughout their academic development (Eccles et al., 1982; Gallagher, 1996; Gonzalez-DeHass, Willems, & Doan Holbein, 2005; Georgiou et al., 2007; Jacobs & Eccles, 1992; Jacobs & Bleeker, 2004). Parents’ math values can have a large effect on their daughters’ perceived math ability (Dickens & Cornell, 1993; Kramer, 1991; Olszewski-Kubilius, Kulieke, Shaw, & Willis, 1990; Sherman, 1982; Sherman & Fennema, 1977). Henman (2010) found that parents can be a positive influence on middle school female students’ science achievement as well. Parents’ influence, however, may vary because they may hold different perceptions of their children’s ability based on their gender (Henman, 2010; Jacobs & Bleeker, 2004; Simpkins et al., 2012). In addition, females may be more susceptible to negative math values than males (Gunderson, Ramirez, Levine, et al., 2012; Hannula, 2002).

Even in adolescence, parents are a needed support, perhaps even more than at any other time. It is in this period when students go through puberty and are more vulnerable to disengaging from school (Kreider, Caspe, Kennedy, & Weiss; 2007). Parents’ involvement seems to be particularly important for racial/ethnic minorities (Kreider et al.). Contrary to general perception, the influence of parents on adolescents can be even more powerful than that of peers (Sands & Plunkett, 2005). Whereas Asian students tend to have an inculcated high academic expectation, African American and Latino males have been found to undervalue the importance of education (Hao & Bonstead-Bruns, 1998; see Meece et al., 2006). African American parents’ expectations directly impact adolescents’ motivation, especially of males (e.g., Wood, Kaplan, & McLoyd, 2007; Wood et al., 2011). Little research, however, has been
done on academic motivation of Latinos and African Americans in rural areas (Meece et al., 2006).

*Teachers’ influence on their students’ math and science values and academic success*

Teachers play perhaps the most prominent role in the successful development of young children’s math education (Lee & Ginsburg, 2009). Teachers’ perceptions about their students’ achievement influence student motivation (Georgiou et al., 2007). Unfortunately, many elementary school teachers, and teachers in general, believe that children’s math abilities are a matter of genetics and/or students’ gender or racial/ethnic makeup (Henman, 2010; Lee & Ginsburg, 2009; Riegle-Crumb & Humphries, 2012). For example, teachers tend to have lower expectations for Latino students than for Caucasians (Tenenbaum & Ruck, 2007). This notion leads teachers to suppose that there is not much that can be done to positively influence those children’s that are not ‘mathematically gifted.’ Teachers were found to be biased against female students with regards to their math ability (Dickhauser & Meyer, 2006). Teachers’ actions reflecting this bias may be one of the reasons for the observed tendency of females to have lower perceived math ability than males (Dickhauser & Meyer). An inclusive and equitable environment is necessary for positive academic experiences and achievement (Pena & Fiestas, 2009; Tan & Barton as cited in Creasy Fowler, 2010).

In addition, teachers’ mastery of the subject being taught is of paramount importance as well as their effectiveness in engaging all students and providing for all the different learning styles (Barton, 1997; Board of Science Education, 2011). Teachers who lack a specialization preparation may not feel confident teaching that particular subject, resulting in poor achievement and a formation of poor values (Lunn, 2002). Lee & Ginsburg (2009) stated that programs that
prepare elementary school teachers that include specific courses in math are very scarce, thus
highlighting the need for better support and professional development opportunities. Teachers
are also the most significant influence on female seventh graders science achievement (Henman,
2010). Hatchell (1998) found that females in particular need encouragement from their teachers.
Teachers are also a significant influence on students’ STEM career choice (Simpson & Oliver,
1990). Because females tend to be more susceptible to the opinion of others (Lee, 2002), it is the
teacher’s role, as well as the parents,’ to encourage female students’ positive values regarding
STEM (Creasy Fowler, 2010; Jenkins, 2006; Oliver, 2011b; Reiss, 2012; Sorensen, 2011).

*Peers’ influence on their friends and the transition to adolescence and middle school*

The transition to middle school coincides with the change from childhood to adolescence. It is at this stage that peers’ influence becomes more central and may have a greater effect on students’ choices and academic achievement than parents and teachers (Gallagher, 1996; Kinney,
1993; Pierce, 2005; Smyth & Hattam, 2004 in Creasy Fowler, 2010; Stake & Nickens, 2005). It
is believed that elementary school environments are, in general, more caring and engaging for all
students and for females in particular (Kedar-Voidovas, 1983). On the other hand, traditional
middle school environments are perceived to be less welcoming and more impersonal (Dotterer
et al., 2009), impacting females more negatively than males (Kramer, 1991; see also Meece et
al., 2006). In a study looking at the progress of students from 6th grade to the junior year of high
school, Wigfield and Meece (1988) found that females tended to dislike math more than males
did throughout those years. Peers may be a contributing factor in females’ math and science
values given that peers’ gender biased values may be particularly influential (Henman, 2010)
given that, at this highly emotional stage, students’ negative math attitudes become heightened
(Cheung, 1988; Lafortune et al., 1999). Dotterer et al. (2009) found that the transition from
elementary to middle school was linked to a decline in academic interest. A current point of
discussion is the comparison between the K-6 and the K-8 school organizational plans. Williams,
Kirst, Haertel, et al. (2010) found no significant difference between distinct school
organizational compositions on academic achievement strong. However, West and Schwerdt
(2012) found students who attended middle school had lower math achievement than their
counterparts in a K-8 setting.

Cultural differences on the path to achievement: An individualistic and ability approach
or a collectivistic and effort approach?

Some differences observed in students’ academic values may be related to cultural
influences rather than to gender and/or racial/ethnic considerations (He, 2007). In general, the
Caucasian culture has an individualistic/capacity approach to success (Green, Deschamps, &
Paez, 2005; He, 2007; Hofstede & McCrae, 2004; Jenkins, 2006; Pena & Fiestas, 2009). Other
non-Caucasian cultures tend to have a more collectivistic/effort approach to success and
achievement (Chen & Stevenson, 1995; Green et al., 2005; Pena & Fiestas, 2009; Schwartz,
2009). For example, while Caucasian-American parents tend to believe that natural ability
influences their children's math achievement; many non-Caucasian parents tend to emphasize
effort (Kreider et al. 2007; Uttal, 1997). Therefore, racial/ethnic minorities may encounter some
cultural conflicts in an educational system where having high ability and focusing on
competition is strongly valued (Dickhäuser & Meyer, 2006). Because having high ability is often
given more weight, a perceived lack of ability may lead to negative internal academic values.
Individualism and collectivism, however, have been found not to be completely opposing
constructs (Green et al., 2005; Oyserman, Coon, & Kemmelmeier, 2002; Rodriguez & Olswang,
2003; Schwartz, 2007).
Parents, teachers, and peers are significant influences in students’ lives. As individuals grow and advance in their academic development, it seems that parents’ influence diminishes while peers’ influence increases, especially in adolescence when individuals are looking for independence from their parents and at the same time acceptance from their peers. Adolescents tend to be very protective of their autonomy, especially with regards to choices that they esteem as a personal matter (Smetana, 1989; Smetana & Asquith, 1994). Although choosing a career can be considered one of the most personal decisions in life (Young, 1994), it appears that adolescents expect and or desire input from external sources, especially from parents (Grotevant, 1988; Hartley, 2011; Palmer & Cochran 1988; Young, 1994). Research indicates that parents tend to be a positive and often the most significant influence in students’ career choice (Adamuti-Trache & Andres, 2008; Bleeker & Jacobs, 2004; Bregman & Killen, 1999; Blustein, 1988, 1989; Blustein, Walbridge, Friedlander, & Palladino, 1991; Ketterson & Blustein, 1997; Kracke, 1997; Meece et al., 2006; Middleton & Loughead, 1993; Palmer & Cochran, 1988; Stage & Maple, 1996). Henman (2010), for example, found that high school female students identified their parents as the most important influence with regards to career choice, followed by friends, and teachers being the third most influential (see also Leewie & DiPetre, 2011). Females are more likely to mention their parents’ education, inspiration, and hard work as more influential elements with regards to career choice than males (Dryler, 1998; Sonnert, 2009). Caucasian parents encourage children to be more independent and tend to interfere less with their choices than Latino parents who encourage a more collectivistic view and expect their children to be more mindful of family’s opinions and needs (He, 2007).
When it comes to STEM careers, it has been found that “STEM majors almost always have at least one scientist in the family, usually a parent,” who served as an example of “STEM-minded careers” (Emdin, 2011). Students whose parents’ had higher levels of education were more likely to choose STEM careers than students from families with parents who did not have a college degree (Adamuti-Trache & Andres, 2008). In another study, Bleeker and Jacobs (2004) found mothers’ beliefs about their children’s future success in math predicted children’s career choices 12 years later. Whether a female perceives that she shares some similarities with the career role-model or not influences their decision on pursuing or not pursuing a STEM career (Lee, 1998). Exposure to successful female scientists and realistic depictions of STEM careers may positively influence females’ interest for such careers (Creasy Fowler, 2010). Males, perhaps more so than females, are more likely to express that the people who influence them most with regards to career choice are those who provide them with information about the career (Sonnert, 2009).

Some of the most common factors considered by people when choosing a career are: personal and academic values, job security, pay, and external influences from parents, teachers, and peers (Sonnert, 2009). Males and females tend to give different reasons for pursuing or not pursuing a STEM career (Miller, Blessing, & Schwartz, 2006; see also Gottfredson, 1981). Females generally prefer careers that involve working with people, whereas males prefer careers working with things (see Lippa, 1998, 2006). Ferriman (2008) indicated that males place more value on good pay and recognition, whereas females place more value on career satisfaction, establishing good relationships as well as being there for their family. Ferriman noted that males presented more intra-individual perspective, while females showed an inter-individual perspective (see also Johnson & Bouchard, 2007a). In other words, males have a tendency,
according to Ferriman, to put their own needs ahead of other people’s needs (i.e., less altruistic), while females showed more interest than males in giving back to the community, and ascribing to the precept that they have a social duty to look for the wellbeing of all its citizens (i.e., more altruistic).

Summary

In conclusion, this review serves as a backdrop for this study by providing a context about: 1) the current demand for STEM-skilled professionals in the U.S. in a time of significant demographic changes and economic challenges; and 2) academic achievement as it relates specifically to STEM. Namely, this review states the importance of the successful STEM recruitment and retention of women, racial/ethnic minorities, and men. Secondly, it provides the research basis for this study on STEM-related values and career choice of females and males, and race/ethnic minority high school students. In sum, this review highlights the importance of high school and earlier grades in addressing the current need for STEM-skilled professionals.
CHAPTER THREE

Methodology

Purpose of the Study

The purpose of this study was to examine high school students’ values about math, perceived math achievement, and STEM career choice.

Participants

Participants were high school students from three rural schools in the northwest U.S. who participated or were involved in a National Science Foundation grant program and the Washington State Imagine Tomorrow competition. Participating students were invited to voluntarily participate in the study by answering a pilot questionnaire. There were thirteen hypotheses examined in this study. The hypotheses were grouped in two categories: 1) math values and perceived math achievement, and 2) altruistic career considerations. Each hypothesis was examined using the following categorical variables: math self-rating, gender, and race/ethnicity.

The sample population consisted of 515 high school students of which 505 provided a self-rating of their math achievement: (52% male [n=269]; 48% female [n=246]). The majority of participants (n=294) were Latinos, followed by Caucasians (n=142) The number of students self-identified as Native American, Asian/Pacific Islander, African American, and Other Race/Ethnicity were too few to analyze.

The study received institutional review board approval from Washington State University prior to data collection (see Appendix A) (IRB File Number 9572). Participants signed a written consent form (see Appendix A) assuring they had been informed of the purpose of the study and the procedures.
Instrumentation

Data was collected by administering the “To Do or Not to Do:” Science, Technology, Engineering, Mathematics hand pilot survey. Some advantages of hand surveys are: 1) high response rate (typically close to 100%); 2) low cost; and 3) presence of a survey administrator to address any questions (Ary, Jacobs, Razavieh, & Sorensen, 2006, p. 416). One disadvantage is the restriction of time and place (Ary et al.). Because potential respondents are already part of specific programs, time and place issues should not be an issue.

Hand surveys, as it has been already mentioned, typically have a high response rate (Ary et al., 2006). An issue with nonrespondents is that, according to research, they tend to differ from respondents in characteristics such as education, motivation, and interest in the topic of the survey, among others (Ary et al.). However, Ary et al. cited various studies by McCarthy and Teitler, Reichman, and Sprachman that indicate that lower response rates do not necessarily translate into biased data.

The “To Do or Not to Do:” Science, Technology, Engineering, Mathematics survey items were based on a review of related literature. Participants were not required to include names. The instrument is composed of 28 5-point Likert scale items ranging from strongly agree to strongly disagree. Ten items were related to external math values with questions statements such as ‘My math teacher says I am good at math,’ ‘My math teacher cares about my success in math,’ and ‘My parents are influencing me to a career in science/math.’ Five items measured internal math values with statements such as ‘I am good at math,’ ‘I like the challenge of math,’ and ‘Math comes easy to me.’ Negative math values was measured with items ‘I am not as good in math as my peers,’ and ‘My math teachers take little interest in my success in math.’ Three items measured altruistic career values (i.e., ‘I want a career in an area that directly helps
people,’ ‘I want a career that directly impacts the sustainability of our planet,’ and ‘I want a career that directly impacts societal issues.’ Four items measured math-as-a-less-altruistic-career values with items such as ‘I see other careers than math as having more impact on societal issues,’ and ‘I see other careers as benefiting people more directly.’

Eleven open-ended questions measured high math rate students’: 1) ages when their respective parents, teachers, and peers became and/or were made aware of being good at math (e.g., ‘At what age did you realize that you were good at math?’, and ‘At what age did your parents recognize and tell you that you were good in math?’ One open-ended question assessed low math rate students’ age in which they realize that math was difficult for them. Three yes/no questions asked low math rate students: ‘Did your peers say you were not good in math?’, Did your teachers say you were not good in math?’, and ‘Did your parents say you were not good in math?’ Low math rate students were also asked three open-ended questioned that looked to assess the subjects in which they felt they were successful as well as the reasons for their success in those courses, and what the teachers of those courses did to help them be successful, if anything. Students who were thinking of choosing a STEM career were asked what was that they enjoyed most about such a career. All students were asked what they enjoyed the least about math. A question to inquire about career choice influence, participants were asked: ‘If there is a person who has significantly impacted your career choice, what it is that they did that had such a strong influence on you?’ Since many participants also provided information as to the nature of that the relationship of that influential person (e.g., ‘My parents,’ ‘My aunt,’ My teacher,’ etc.), that information was used to also inquire about what relationships tend to be more influential on students’ career choice. In addition, demographic data on the participants was solicited including age, gender, ethnicity, and school grade (i.e., freshman, sophomore, junior, senior).
Validity of instrument

The validity of a measuring instrument refers to whether it is measuring what it intends to measure (Ary et al., 2006). Validity is essential for the interpretation and use of test scores (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999). In order to assess the survey’s validity, the dissertation committee members and other professors with vast experience and expertise in the fields of educational psychology, and teaching and learning examined the survey. Experts provided feedback on its validity and how to improve it, addressing ambiguities or misunderstandings before sending it to participants. Considerations about such elements as participants’ age, language proficiency, and school setting, were also taken into consideration in order to maximize the instrument’s validity. To assess the validity of an instrument, experts on the topics of the survey usually look at its content to judge if the survey appears valid (i.e., face validity), if it actually measures what it intends to measure, and whether the items are representative of the constructs of interest for the study (Ary et al., 2006). A construct itself cannot be measured; only the behaviors or variables that comprise it can be tested (Drummond & Jones, 2006). Two other considerations may affect the validity of an instrument: 1) the importance of the topic to the respondents; and 2) the protection of the respondents’ anonymity (Ary et al.). As participants of STEM-related programs, the participants of this study are expected to be interested on the subject. The respondents’ anonymity was protected as they were not asked to identify themselves nor their school.
Reliability

Reliability is an important precondition of validity (American Educational Research Association [AERA] et al., 1999). In order for survey data to be useful, it must be reliable, meaning that the respondents’ answers must be consistent (Ary et al., 2006). For this survey, internal consistency was checked by “building some redundancy into the instrument” by repeating rephrased items on the same topic (Ary et al. p. 440) thus checking for correlation among those items (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education).

Procedures

Students in math and math/science combined classrooms in three rural high schools received an invitation to voluntarily participate in the study by answering a hand survey. Classroom teachers handed out the surveys, explained the general purpose of the study, and answered general questions about the study. Students were given 15 minutes to complete the survey. Teachers scanned each student’s survey to ensure completeness of answers.

Design and analysis

This study is descriptive as it uses a survey instrument for data collection with the intent of generalizing from a sample to a population (e.g., see Babbie, 1990). “Surveys do not require complex statistical analyses” (Ary et al., 2006, p. 440). The data were analyzed using descriptive statistics including Mean, Standard Deviations, percentages, and Cronbach alpha correlations and regressions. For example, this study reports the number and percentages of participants who responded on a Likert-scale item about their perceptions about encouragement to pursue a career in STEM. Converting numbers to percentages is useful as it permits discussion about the
proportion of participants who respond a certain way, as well as allowing comparisons (Ary et al.). Statistical analyses included descriptive analysis, correlations and linear regressions. The SPSS package was used for all statistical analyses.
CHAPTER FOUR

Results

The purpose of this study was to examine high school students’ values about math, perceived math achievement, and STEM career choice. There are thirteen hypotheses examined in this study. The hypotheses are grouped in two categories: 1) math values and perceived math achievement, and 2) altruistic career considerations. Additionally, six open-ended questions were asked about perceived academic success and career considerations. This third part includes the results of questions regarding academic/career enjoyment, academic/career success, and additional career considerations.

Data was collected using a survey marked as Appendix C. Eight variables were considered throughout the analysis: 1) gender, 2) race/ethnicity (Caucasian or Latino), 3) perceived math achievement (whether the student perceived to be an A, B, C, D, or F in math), 4) internal math values (e.g., I am good at math), 5) external math values (e.g., My math teacher says I am good at math), 6) negative math values (e.g., I am not as good in math as my peers), 7) altruistic career values (e.g., I want a career in an area that directly helps people), and 8) math-as-less-altruistic values (e.g., I see other careers than math as having more impact on societal issues). Each hypothesis was looked at by math self-rating, gender, and race/ethnicity.

Sample Composition

The overall sample population consisted of 515 high school students of which 505 provided a self-rating of their math achievement. The majority (52%) of participants were male (n=269); 48% of the sample was female (n=246). Of the 507 participants who provided their race/ethnicity, 58% (n=294) was Latino, followed by Caucasians (28%, n=142),
Native Americans (5%, n=27), Asian/Pacific Islanders (1%, n=7), and African Americans (1%, n=4); 7% of participants did not provide a race/ethnicity or selected the category of Other (n=33). Of all participants, 512 identified their academic grade; 17% (n=89) were freshmen, 35% sophomores (n=177), 30% juniors (n=153), and 18% were seniors (n=93).

The majority of students (53%, n=265) perceived their math achievement as C or lower; 47% (n=240) rated themselves as B or higher in math. Overall, 8% of students (n=41) perceived themselves as A in math achievement, 39% as B (n=199), 38% as C (n=190), 11% as D (n=55), and 4% as F (n=20).

The majority of students who rated themselves as C or lower in math were female (53%, n=140); males were 47% (n=125). Of students who perceived themselves as B or higher in math, 57% (n=136) was male. Less than half (43%, n=104) of females rated themselves as high in math achievement while 51% of males rated themselves as high in math achievement. Less than 5% (n=11) of females perceived themselves as A in math, compared to 11% (n=30) of males.

Of students who rated themselves as low in math achievement, Latinos were the majority while they were less than half of those who rated themselves as high in math achievement. Caucasians (61%, n=86) rated themselves as high in math achievement in a greater proportion than Latinos (39%, n=115). Conversely, Latinos (58%, n=170) rated themselves as low in math achievement in a greater proportion than Caucasians (39%, n=55). Latino high school students rated themselves as F, D, or C in math in greater percentages than Caucasians (5% to 0, 13% to 6%, and 41% to 33% respectively).
Math Values and Perceived Math Achievement

*Hypothesis 1:*

No relationship exists between internal math values and perceived math achievement in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between internal math values and perceived math achievement in high school students, \( r(505) = .68, p = .001 \).

A regression analysis was used to test if internal math values significantly predicted perceived math achievement in high school students. The results of the regression indicated the predictor explained 46% of the variance (\( R^2 = .46, R^2_{adj.} = .46, F(1, 503) = 430.97, p = .001 \)). It was found that internal math values significantly predicted perceived math achievement (\( \beta = .68, p = .001 \)).

In order to better understand internal math values and perceived math achievement by math self-rating, the responses to specific survey questions were further examined; specifically in the area of self-perceptions about ability and attitudes (see Table 1).

*Hypothesis 1b (by gender):*

Additional findings related to hypothesis one: No relationship exists between internal math values and perceived math achievement in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between internal math values and perceived math achievement in both male, \( r(261) = .70, p = .001 \), and female high school students, \( r(244) = .65, p = .001 \).
Table 1

*Frequency of Students’ Perceptions on Ability by Perceived Math Achievement*

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree/Agree</th>
<th>Neutral</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I am good at math</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>88% of high math students</td>
<td>11% of high math students</td>
<td>1% of high math students</td>
<td></td>
</tr>
<tr>
<td>15% of low math students</td>
<td>53% of low math students</td>
<td></td>
<td>No high math student strongly disagreed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>32% of low math students</td>
</tr>
<tr>
<td><strong>I like the challenge of math</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63% of high math students</td>
<td>26% of high math students</td>
<td>12% of high math students</td>
<td></td>
</tr>
<tr>
<td>18% of low math students</td>
<td>30% of low math students</td>
<td></td>
<td>52% of low math students</td>
</tr>
<tr>
<td><strong>I like the challenge of science</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51% of high math students</td>
<td>27% of high math students</td>
<td>22% of high math students</td>
<td></td>
</tr>
<tr>
<td>34% of low math students</td>
<td>33% of low math students</td>
<td></td>
<td>34% of low math students</td>
</tr>
<tr>
<td><strong>Math comes easy to me</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65% of high math students</td>
<td>28% of high math students</td>
<td>8% of high math students</td>
<td></td>
</tr>
<tr>
<td>11% of low math students</td>
<td>31% of low math students</td>
<td></td>
<td>58% of low math students</td>
</tr>
<tr>
<td><strong>Math teachers teach the way I like to learn</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48% of high math students</td>
<td>35% of high math students</td>
<td>17% of high math students</td>
<td></td>
</tr>
<tr>
<td>20% of low math students</td>
<td>40% of low math students</td>
<td></td>
<td>40% of low math students</td>
</tr>
</tbody>
</table>

*Note.* High Math Students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.

Regression analyses were used to test if internal math values significantly predicted perceived math achievement in high school students. The results of the regressions indicated the predictor explained 49% of the variance in males ($R^2 = .49$, $R^2_{adj.} = .48$, $F(1, 259) = 244.29$, $p = .001$) and 43% of the variance in females ($R^2 = .43$, $R^2_{adj.} = .42$, $F(1, 242) = 179.72$, $p = .001$). It was found that internal math values significantly predicted perceived math achievement both in male high school students ($\beta = .70$, $p = .001$) and in female high school students ($\beta = .65$, $p = .001$).
In order to better understand internal math values and perceived math achievement by gender, the responses to specific survey questions were further examined; specifically in the area of self-perceptions about math ability (see Table 2).

Table 2

| Frequency of Students’ Perceived Math Ability Awareness by Academic Stage and by Gender |
|---------------------------------|-----------------|------------------|-----------------|
|                                 | Elementary School | Middle School    | High School     |
| In what academic stage do high math students first become aware of being good at math? |
| 56% overall                     | 37% overall      | 7% overall       |
| 63% were male                   | 54% were female  | 67% were male    |
| 62% of males                    | 30% of males     | 8% of males      |
| 48.5% of females                | 46.5% of females | 5% of females    |
| In what academic stage do low math students first realize that math is difficult for them? |
| 28% overall                     | 49% overall      | 23% overall      |
| 54% were female                 | 51% were male    | 60% were female  |
| 27% of males                    | 54% of males     | 19% of males     |
| 29% of females                  | 45% of females   | 26% of females   |

*Note.* Students eleven years old or younger categorized as Elementary School, 12-14 years old as Middle School, and 15+ years old as High School. High Math Students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.

**Hypothesis 1c (by race/ethnicity):**

Additional findings related to hypothesis one: No relationship exists between internal math values and perceived math achievement in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between internal math values and perceived math achievement in both Caucasian, \( r(141) = .72, p = .001 \), and Latino high school students, \( r(285) = .66, p = .001 \).

Regression analyses were used to test if internal math values significantly predicted perceived math achievement in high school students. The results of the regressions indicated the
predictor explained 51% of the variance in Caucasians ($R^2 = .51$, $R^2_{adj.} = .51$, $F(1, 139) = 145.71$, $p = .001$) and 44% of the variance in Latinos ($R^2 = .44$, $R^2_{adj.} = .44$, $F(1, 283) = 221.46$, $p = .001$). It was found that internal math values significantly predicted perceived math achievement both in Caucasian ($\beta = .72$, $p = .001$) and Latino high school students ($\beta = .66$, $p = .001$).

In order to better understand internal math values and perceived math achievement by race/ethnicity, the responses to specific survey questions were further examined; specifically in the area of self-perceptions about math ability (see Table 3).

Table 3

<table>
<thead>
<tr>
<th>In what academic stage do high math students first become aware of being good at math?</th>
<th>Elementary School</th>
<th>Middle School</th>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>56% overall</td>
<td>37% overall</td>
<td>7% overall</td>
<td></td>
</tr>
<tr>
<td>50% were Latino</td>
<td>48% were Latino</td>
<td>53% were Latino</td>
<td></td>
</tr>
<tr>
<td>34% were Caucasian</td>
<td>39% were Caucasian</td>
<td>40% were Caucasian</td>
<td></td>
</tr>
<tr>
<td>56% of Latinos</td>
<td>37% of Latinos</td>
<td>7% of Latinos</td>
<td></td>
</tr>
<tr>
<td>52% of Caucasians</td>
<td>40% of Caucasians</td>
<td>7% of Caucasians</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In what academic stage do low math students first realize that math is difficult for them?</th>
<th>Elementary School</th>
<th>Middle School</th>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td>28% overall</td>
<td>49% overall</td>
<td>23% overall</td>
<td></td>
</tr>
<tr>
<td>62% were Latino</td>
<td>66% were Latino</td>
<td>64% were Latino</td>
<td></td>
</tr>
<tr>
<td>21% were Caucasian</td>
<td>20% were Caucasian</td>
<td>30% were Caucasian</td>
<td></td>
</tr>
<tr>
<td>26% of Latinos</td>
<td>51% of Latinos</td>
<td>23% of Latinos</td>
<td></td>
</tr>
<tr>
<td>26% of Caucasians</td>
<td>43% of Caucasians</td>
<td>31% of Caucasians</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Students eleven years old or younger categorized as Elementary School, 12-14 years old as Middle School, and 15+ years old as High School. Latino and Caucasian students comprised 87% of all the students who answered this question ($n = 229$). The number of students self-identified as Native American, Asian/Pacific Islander, African American, and Other Race/Ethnicity were too few to analyze but are included in the Overall category. High Math Students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.
Hypothesis 2:

No relationship exists between external math values and perceived math achievement in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between external math values and perceived math achievement in high school students, \( r(505) = .53, p = .001 \).

A regression analysis was used to test if external math values significantly predicted perceived math achievement in high school students. The results of the regression indicated the predictor explained 28% of the variance (\( R^2 = .28, R^2\text{adj.} = .28, F(1, 503) = 191.96, p = .001 \)). It was found that external math values significantly predicted perceived math achievement in high school students (\( \beta = .53, p = .001 \)).

In order to better understand external math values and perceived math achievement by self-rating, the responses to specific survey questions were further examined; specifically in the area of perceptions and attitudes about other people’s interest and assessment on their math ability (see Table 4).

Hypothesis 2b (by gender):

Additional findings related to hypothesis two: No relationship exists between external math values and perceived math achievement in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between external math values and perceived math achievement in both male, \( r(261) = .54, p = .001 \), and female high school students, \( r(244) = .49, p = .001 \).
Table 4

**Frequency of Students’ Perceptions About Others’ Assessment on Their Math Ability**

<table>
<thead>
<tr>
<th>Strongly Agree/Agree</th>
<th>Neutral</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>My peers say I am good at math</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75% of high math students</td>
<td>22% of high math students</td>
<td>3% of high math students</td>
</tr>
<tr>
<td>17% of low math students</td>
<td>53% of low math students</td>
<td>30% of low math students</td>
</tr>
<tr>
<td><strong>My math teacher says I am good at math</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71% of high math students</td>
<td>25% of high math students</td>
<td>4% of high math students</td>
</tr>
<tr>
<td>17% of low math students</td>
<td>53% of low math students</td>
<td>31% of low math students</td>
</tr>
<tr>
<td>No low math rate students strongly agreed</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>My science teacher says I am good at math</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43% of high math students</td>
<td>47% of high math rate students</td>
<td>10% of high in math students</td>
</tr>
<tr>
<td>15% of low math students</td>
<td>53% of low math students</td>
<td>32% of low math students</td>
</tr>
</tbody>
</table>

*Note.* High Math Students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.

Regression analyses were used to test if external math values significantly predicted perceived math achievement in high school students. The results of the regressions indicated the predictor explained 30% of the variance in males ($R^2 = .30$, $R^2_{adj.} = .29$, $F(1, 259) = 108.87$, $p = .001$) and 24% of the variance in females ($R^2 = .24$, $R^2_{adj.} = .24$, $F(1, 242) = 76.81$, $p = .001$). It was found that external math values significantly predicted perceived math achievement both in male high school students ($\beta = .54$, $p = .001$) and in female high school students ($\beta = .49$, $p = .001$).

In order to better understand external math values and perceived math achievement by gender, the responses to specific survey questions were further examined; specifically in the areas of perceptions of self and others about math ability (see Tables 5 and 6).
Table 5

*Frequency of High Math Students’ Perceptions About Others’ Assessment on Their Math Ability by Academic Stage and by Gender*

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In what academic stage do high math students first are made aware of being good at math by their peers?</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49% overall</td>
<td>41% overall</td>
<td>10% overall</td>
<td></td>
</tr>
<tr>
<td>63% were male</td>
<td>57% were female</td>
<td>85% were male</td>
<td></td>
</tr>
<tr>
<td>54% of males</td>
<td>32% of males</td>
<td>14% of males</td>
<td></td>
</tr>
<tr>
<td>41% of females</td>
<td>56% of females</td>
<td>3% of females</td>
<td></td>
</tr>
<tr>
<td><strong>In what academic stage do high math students first are made aware of being good at math by their teachers?</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>54% overall</td>
<td>36% overall</td>
<td>10% overall</td>
<td></td>
</tr>
<tr>
<td>59% were male</td>
<td>53% were male</td>
<td>57% were male</td>
<td></td>
</tr>
<tr>
<td>56% of males</td>
<td>34% of males</td>
<td>10% of males</td>
<td></td>
</tr>
<tr>
<td>50.5% of females</td>
<td>40% of females</td>
<td>9.5% of females</td>
<td></td>
</tr>
<tr>
<td><strong>In what academic stage do high math students first are made aware of being good at math by their parents?</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63% overall</td>
<td>27% overall</td>
<td>10% overall</td>
<td></td>
</tr>
<tr>
<td>63% were male</td>
<td>56% were female</td>
<td>55% were male</td>
<td></td>
</tr>
<tr>
<td>69% of males</td>
<td>22% of males</td>
<td>9% of males</td>
<td></td>
</tr>
<tr>
<td>53% of females</td>
<td>37% of females</td>
<td>10% of females</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Students eleven years old or younger categorized as Elementary School, 12-14 years old as Middle School, and 15+ years old as High School. Latino and Caucasian students comprised 87% of all the students who answered this question (n = 229). High Math Students comprise those students who rated themselves as A or B in math achievement.

Table 6

*Frequency of Low Math Students’ Perceptions About Others’ Assessment on Their Math Ability by Gender*

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What percentage of low math rate students say their peers/teachers/parents tell them they are not good in math?</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relation</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Peers</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Teachers</td>
<td>14</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td>Parents</td>
<td>16</td>
<td>17</td>
<td>15</td>
</tr>
</tbody>
</table>

*Note.* Low math students comprise those students who rated themselves as C or below in math achievement.
Hypothesis 2c (by race/ethnicity):

Additional findings related to hypothesis two: No relationship exists between external math values and perceived math achievement in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between external math values and perceived math achievement in both Caucasian, \( r(141) = .58, p = .001 \), and Latino high school students, \( r(285) = .47, p = .001 \).

Regression analyses were used to test if external math values significantly predicted perceived math achievement in high school students. The results of the regressions indicated the predictor explained 33% of the variance in Caucasians (\( R^2 = .33, R^2\text{adj.} = .33, F(1, 139) = 69.75, p = .001 \)) and 22% of the variance in Latinos (\( R^2 = .22, R^2\text{adj.} = .22, F(1, 283) = 78.71, p = .001 \)).

It was found that external math values significantly predicted perceived math achievement both in Caucasian (\( \beta = .58, p = .001 \)) and Latino high school students (\( \beta = .47, p = .001 \)).

In order to better understand external math values and perceived math achievement by race/ethnicity, the responses to specific survey questions were further examined; specifically in the areas of perceptions of self and others about math ability (see Tables 7 and 8).
Table 7

Frequency of High Math Students’ Perceptions About Others’ Assessment on Their Math Ability by Academic Stage and by Race/Ethnicity

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In what academic stage do high math students first are made aware of being good at math by their peers?</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49% overall</td>
<td>41% overall</td>
<td>10% overall</td>
<td></td>
</tr>
<tr>
<td>52% were Latino</td>
<td>50% were Latino</td>
<td>50% were Latino</td>
<td></td>
</tr>
<tr>
<td>33% were Caucasian</td>
<td>38% were Caucasians</td>
<td>30% were Caucasian</td>
<td></td>
</tr>
<tr>
<td>49.5% of Latinos</td>
<td>41% of Latinos</td>
<td>9.5% of Latinos</td>
<td></td>
</tr>
<tr>
<td>46% of Caucasians</td>
<td>46% of Caucasians</td>
<td>8% of Caucasians</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In what academic stage do high math students first are made aware of being good at math by their teachers?</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>54% overall</td>
<td>36% overall</td>
<td>9% overall</td>
<td></td>
</tr>
<tr>
<td>43% were Latino</td>
<td>55% were Latino</td>
<td>50% were Latino</td>
<td></td>
</tr>
<tr>
<td>37% were Caucasian</td>
<td>36% were Caucasian</td>
<td>40% were Caucasian</td>
<td></td>
</tr>
<tr>
<td>48% of Latinos</td>
<td>42% of Latinos</td>
<td>10% of Latinos</td>
<td></td>
</tr>
<tr>
<td>54% of Caucasians</td>
<td>35% of Caucasians</td>
<td>10% of Caucasians</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
<th>High School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In what academic stage do high math students first are made aware of being good at math by their parents?</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63% overall</td>
<td>27% overall</td>
<td>10% overall</td>
<td></td>
</tr>
<tr>
<td>48% were Latino</td>
<td>51% were Latino</td>
<td>60% were Latino</td>
<td></td>
</tr>
<tr>
<td>34% were Caucasian</td>
<td>42% were Caucasian</td>
<td>30% were Caucasian</td>
<td></td>
</tr>
<tr>
<td>60% of Latinos</td>
<td>28% of Latinos</td>
<td>12% of Latinos</td>
<td></td>
</tr>
<tr>
<td>60% of Caucasians</td>
<td>32% of Caucasians</td>
<td>8% of Caucasians</td>
<td></td>
</tr>
</tbody>
</table>

Note. Students eleven years old or younger categorized as Elementary School, 12-14 years old as Middle School, and 15+ years old as High School. Latino and Caucasian students comprised 87% of all the students who answered this question (n = 229). The number of students self-identified as Native American, Asian/Pacific Islander, African American, and Other Race/Ethnicity were too few to analyze but are included in the Overall category. High Math Students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.

Table 8

Frequency of Low Math Students’ Perceptions About Others’ Assessment on Their Math Ability by Race/Ethnicity

<table>
<thead>
<tr>
<th>What percentage of low math rate students say their peers/teachers/parents tell them they are not good in math?</th>
<th>Overall %</th>
<th>Latinos %</th>
<th>Caucasians %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peers</td>
<td>22</td>
<td>20.5</td>
<td>18</td>
</tr>
<tr>
<td>Teachers</td>
<td>14</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Parents</td>
<td>16</td>
<td>16</td>
<td>12</td>
</tr>
</tbody>
</table>

Note. Latino and Caucasian students comprised 87% of all the students who answered this question (n = 229). The number of students self-identified as Native American, Asian/Pacific Islander, African American, and Other Race/Ethnicity were too few to analyze but are included in the Overall category. Low math students comprise those students who rated themselves as C or below in math achievement.
Hypothesis 3:

No relationship exists between external and internal math values in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between external math values and internal math values in high school students, $r(505) = .69, p = .001$.

A regression analysis was used to test if external math values significantly predicted internal math values in high school students. The results of the regression indicated the predictor explained 48% of the variance ($R^2 = .48$, $R^2_{adj.} = .48$, $F(1, 503) = 463.60, p = .001$). It was found that external math values significantly predicted internal math values ($\beta = .69, p = .001$).

In order to better understand external math values and internal math values by self-rating, the responses to specific survey questions were further examined; specifically in the areas of perceptions of teachers’ motivating and challenging disposition (see Table 9).

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree/</th>
<th>Neutral</th>
<th>Strongly Disagree/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agree</td>
<td></td>
<td>Disagree</td>
</tr>
<tr>
<td>My math teacher is highly motivating</td>
<td>66% of high math students</td>
<td>22% of high math students</td>
<td>12% of high math students</td>
</tr>
<tr>
<td></td>
<td>45% of low math students</td>
<td>36% of low math students</td>
<td>20% of low math students</td>
</tr>
<tr>
<td>My math teacher is highly challenging</td>
<td>61% of high math students</td>
<td>29% of high math students</td>
<td>11% of high math students</td>
</tr>
<tr>
<td></td>
<td>42% of low math students</td>
<td>43% of low math students</td>
<td>15% of low math students</td>
</tr>
</tbody>
</table>

Note. High math students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.
Hypothesis 3b (by gender):

Additional findings related to hypothesis three: No relationship exists between external and internal math values in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between external and internal math values in both male, $r(269) = .70$, $p = .001$, and female high school students, $r(246) = .69$, $p = .001$.

Regression analyses were used to test if external math values significantly predicted internal math values in high school students. The results of the regressions indicated the predictor explained 49% of the variance in males ($R^2 = .49$, $R^2_{adj.} = .49$, $F(1, 267) = 256.44$, $p = .001$) and 48% of the variance in females ($R^2 = .48$, $R^2_{adj.} = .47$, $F(1, 244) = 221.42$, $p = .001$). It was found that external math values significantly predicted internal math values both in male high school students ($\beta = .70$, $p = .001$) and in female high school students ($\beta = .69$, $p = .001$).

Hypothesis 3c (by race/ethnicity):

Additional findings related to hypothesis three: No relationship exists between external and internal math values in high school students.

By race/ethnicity

The null hypothesis was rejected and a statistically significant positive relationship exists between external math values and internal math values in both Caucasian, $r(142) = .74$, $p = .001$, and Latino high school students, $r(294) = .66$, $p = .001$.

Regression analyses were used to test if external math values significantly predicted internal math values in high school students. The results of the regressions indicated the predictor explained 55% of the variance in Caucasians ($R^2 = .55$, $R^2_{adj.} = .55$, $F(1, 140) = 173.73$, $p = .001$) and 44% of the variance in Latinos ($R^2 = .44$, $R^2_{adj.} = .44$, $F(1, 292) = 229.60$, $p = .001$).
p = .001). It was found that external math values significantly predicted internal math values both in Caucasian (β = .74, p = .001) and Latino high school students (β = .66, p = .001).

**Hypothesis 4:**

No relationship exists between negative math values and perceived math achievement in high school students.

The null hypothesis was rejected and a statistically significant negative relationship exists between negative math values and perceived math achievement in high school students, r(505) = -.44, p = .001.

A regression analysis was used to test if negative math values significantly predicted perceived math achievement in high school students. The results of the regression indicated the predictor explained 20% of the variance (R² = .20, R²adj. = .20, F(1, 503) = 123.72, p = .001). It was found that negative math values significantly predicted perceived math achievement (β = -.44, p = .001). For some additional descriptive information on the relationship between negative math values and perceived math achievement, see Table 10.

**Table 10**

*Frequency of Students’ Perceptions on Their Math Ability Compared to Their Peers’ by Perceived Math Achievement*

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree/Agree</th>
<th>Neutral</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am not as good in math as my peers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8% of high math students</td>
<td>33% of high math students</td>
<td>59% of high math students</td>
<td></td>
</tr>
<tr>
<td>49% of low math students</td>
<td>37% of low math students</td>
<td>14% of low math students</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* High math students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.
Hypothesis 4b (by gender):

Additional findings related to hypothesis four: No relationship exists between negative math values and perceived math achievement in high school students.

The null hypothesis was rejected and a statistically significant negative relationship exists between negative math values and perceived math achievement in both male, \( r(261) = -.42, p = .001 \), and female high school students, \( r(244) = -.49, p = .001 \).

Regression analyses were used to test if negative math values significantly predicted perceived math achievement in high school students. The results of the regressions indicated the predictor explained 17% of the variance in males (\( R^2 = .17, R^2_{adj.} = .17, F(1, 259) = 54.26, p = .001 \)) and 24% of the variance in females (\( R^2 = .24, R^2_{adj.} = .23, F(1, 242) = 74.95, p = .001 \)). It was found that negative math values significantly predicted perceived math achievement both in male high school students (\( \beta = -.42, p = .001 \)) and in female high school students (\( \beta = -.49, p = .001 \)).

Hypothesis 4c (by race/ethnicity):

Additional findings related to hypothesis four: No relationship exists between negative math values and perceived math achievement in high school students.

The null hypothesis was rejected and a statistically significant negative relationship exists between negative math values and perceived math achievement in both Caucasian, \( r(141) = -.48, p = .001 \), and Latino high school students, \( r(285) = -.36, p = .001 \).

Regression analyses were used to test if negative math values significantly predicted perceived math achievement in high school students. The results of the regressions indicated the predictor explained 23% of the variance in Caucasians (\( R^2 = .23, R^2_{adj.} = .23, F(1, 139) = 42.47, p = .001 \)) and 13% of the variance in Latinos (\( R^2 = .13, R^2_{adj.} = .12, F(1, 283) = 40.69, p = .001 \)).
p = .001). It was found that negative math values significantly predicted perceived math achievement both in Caucasian (β = -.48, p = .001) and Latino high school students (β = -.36, p = .001).

Altruistic Career Considerations

_Hypothesis 5:_

No relationship exists between perceived math achievement and altruistic career values in high school students.

The null hypothesis failed to be rejected and no statistically significant relationship exists between perceived math achievement and altruistic career values in high school students, r(505) = .05, p = .28, R² = .002.

_Hypothesis 5b (by gender):_

Additional findings related to hypothesis five: No relationship exists between perceived math achievement and altruistic career values in high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between perceived math achievement and altruistic career values in male, r(261) = .06, p = .34, R² = .004, nor in female high school students, r(244) = .06, p = .36, R² = .003.

_Hypothesis 5c (by race/ethnicity):_

Additional findings related to hypothesis five: No relationship exists between perceived math achievement and altruistic career values in high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between perceived math achievement and altruistic career values in Caucasians, r(141) = -.001, p = .99, R² = .001 nor in Latino high school students, r(285) = .07, p = .27, R² = .004.
Hypothesis 6:

No relationship exists between internal math values and altruistic career values of high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between internal math values and altruistic career values in high school students, $r(505) = .19$, $p = .001$.

A regression analysis was used to test if internal math values significantly predicted altruistic career values in high school students. The results of the regression indicated the predictor explained 4% of the variance ($R^2 = .04$, $R^2_{adj.} = .03$, $F(1, 503) = 18.28$, $p = .001$). It was found that internal math values significantly predicted altruistic career values ($\beta = .19$, $p = .001$). For items related to altruistic career values see Table 11.

Table 11

<table>
<thead>
<tr>
<th>I want a career in an area that directly helps people</th>
<th>Strongly Agree/Agree</th>
<th>Neutral</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I want a career in an area that directly helps people</td>
<td>45% of high math students</td>
<td>38% of high math students</td>
<td>17% of high math students</td>
</tr>
<tr>
<td></td>
<td>52% of low math students</td>
<td>35% of low math students</td>
<td>13% of low math students</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I want a career that directly impacts the sustainability of our planet</th>
<th>Strongly Agree/Agree</th>
<th>Neutral</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I want a career that directly impacts the sustainability of our planet</td>
<td>25% of high math students</td>
<td>41% of high math students</td>
<td>34% of high math students</td>
</tr>
<tr>
<td></td>
<td>17% of low math students</td>
<td>46% of low math students</td>
<td>38% of low math students</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I want a career that directly impacts societal issues</th>
<th>Strongly Agree/Agree</th>
<th>Neutral</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I want a career that directly impacts societal issues</td>
<td>27% of high math students</td>
<td>49% of high math rate students</td>
<td>24% of high in math students</td>
</tr>
<tr>
<td></td>
<td>23% of low math students</td>
<td>46% of low math students</td>
<td>30% of low math students</td>
</tr>
</tbody>
</table>

*Note.* High math students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.
Hypothesis 6b (by gender):

Additional findings related to hypothesis six: No relationship exists between internal math values and altruistic career values of high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between internal math values and altruistic career values in both male, \( r(269) = .14, p = .03 \), and female high school students, \( r(246) = .30, p = .001 \).

Regression analyses were used to test if internal math values significantly predicted altruistic career values in high school students. The results of the regressions indicated the predictor explained 2% of the variance in males (\( R^2 = .02, R^2\text{adj.} = .02, F(1, 267) = 4.96, p = .03 \)) and 9% of the variance in females (\( R^2 = .09, R^2\text{adj.} = .08, F(1, 244) = 23.35, p = .001 \)). It was found that internal math values significantly predicted altruistic career values both in male high school students (\( \beta = .14, p = .03 \)) and in female high school students (\( \beta = .30, p = .001 \)).

Hypothesis 6c (by race/ethnicity):

Additional findings related to hypothesis six: No relationship exists between internal math values and altruistic career values of high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between internal math values and altruistic career values in both Caucasian, \( r(142) = .20, p = .02 \), and Latino high school students, \( r(294) = .18, p = .002 \).

Regression analyses were used to test if internal math values significantly predicted altruistic career values in high school students. The results of the regressions indicated the predictor explained 4% of the variance in Caucasians (\( R^2 = .04, R^2\text{adj.} = .03, F(1, 140) = 5.53, p = .02 \)) and 3% of the variance in Latinos (\( R^2 = .03, R^2\text{adj.} = .03, F(1, 292) = 9.93, p = .002 \)). It
was found that internal math values significantly predicted altruistic career values both in Caucasian (β = .20, p = .02) and Latino high school students (β = .18, p = .002).

Hypothesis 7:

No relationship exists between external math values and altruistic career values of high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between external math values and altruistic career values in high school students, r(505) = .21, p = .001.

A regression analysis was used to test if external math values significantly predicted altruistic career values in high school students. The results of the regression indicated the predictor explained 5% of the variance (R² = .05, R²adj. = .04, F(1, 503) = 23.90, p = .001). It was found that external math values significantly predicted altruistic career values (β = .21, p = .001).

Hypothesis 7b (by gender):

Additional findings related to hypothesis seven: No relationship exists between external math values and altruistic career values of high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between external math values and altruistic career values in both male, r(269) = .20, p = .001, and female high school students, r(246) = .27, p = .001.

Regression analyses were used to test if external math values significantly predicted altruistic career values in high school students. The results of the regressions indicated the predictor explained 4% of the variance in males (R² = .04, R²adj. = .04, F(1, 267) = 11.62, p =
and 7% of the variance in females (R² = .07, R²adj. = .07, F(1, 244) = 18.37, p = .001). It was found that external math values significantly predicted altruistic career values both in male high school students (β = .20, p = .001) and in female high school students (β = .27, p = .001).

**Hypothesis 7c (by race/ethnicity):**

Additional findings related to hypothesis seven: No relationship exists between external math values and altruistic career values of high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between external math values and altruistic career values in both Caucasian, r(142) = .20, p = .02, and Latino high school students, r(294) = .21, p = .001.

Regression analyses were used to test if external math values significantly predicted altruistic career values in high school students. The results of the regressions indicated the predictor explained 4% of the variance in Caucasians (R² = .04, R²adj. = .03, F(1, 140) = 5.74, p = .02) and 4% of the variance in Latinos (R² = .04, R²adj. = .04, F(1, 292) = 13.21, p = .001). It was found that external math values significantly predicted altruistic career values both in Caucasian (β = .20, p = .02) and Latino high school students (β = .21, p = .001).

**Hypothesis 8:**

No relationship exists between altruistic and math-as-less-altruistic career values of high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between altruistic career values and math-as-less-altruistic career values in high school students, r(505) = .11, p = .01.
A regression analysis was used to test if altruistic career values significantly predicted math-as-less-altruistic career values in high school students. The results of the regression indicated the predictor explained 1% of the variance ($R^2 = .01$, $R^2_{adj.} = .01$, $F(1, 503) = 6.46$, $p = .01$). It was found that altruistic career values significantly predicted math-as-less-altruistic career values ($\beta = .11$, $p = .01$). For items related to notions of math as a less altruistic career see Table 12.

Table 12

*Frequency of Students’ Perceptions on Math as a Less Altruistic Career by Perceived Math Achievement*

<table>
<thead>
<tr>
<th>Strongly Agree/Agree</th>
<th>Neutral</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I see other careers than math as benefiting people more directly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45% of high math students</td>
<td>45% of high math students</td>
<td>10% of high math students</td>
</tr>
<tr>
<td>47% of low math students</td>
<td>45% of low math students</td>
<td>8% of low math students</td>
</tr>
<tr>
<td>A career in math has little impact on societal issues and problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6% of high math students</td>
<td>53% of high math students</td>
<td>40% of high math students</td>
</tr>
<tr>
<td>16% of low math students</td>
<td>56% of low math students</td>
<td>28% of low math students</td>
</tr>
<tr>
<td>I see other careers than math as having more impact on societal issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34% of high math students</td>
<td>53% of high math rate students</td>
<td>13% of high in math students</td>
</tr>
<tr>
<td>38% of low math students</td>
<td>52% of low math students</td>
<td>11% of low math students</td>
</tr>
</tbody>
</table>

*Note.* High math students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.

*Hypothesis 8b (by gender):*

Additional findings related to hypothesis eight: No relationship exists between math-as-less-altruistic career values and altruistic career values of high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between altruistic career values and math-as-less-altruistic career values in female high school...
students, r(246) = .07, p = .14, R² = .005. However, the null hypothesis was rejected and a statistically significant positive relationship exists between altruistic career values and math-as-less-altruistic career values in male high school students, r(269) = .14, p = .01.

A regression analysis was used to test if altruistic career values significantly predicted math-as-less-altruistic career values in male high school students. The results of the regression indicated the predictor explained 2% of the variance in male high school students (R² = .02, R²adj. = .02, F(1, 267) = 5.49, p = .02). It was found that math-as-less-altruistic career values significantly predicted altruistic career values in male high school students (β = .14, p = .02).

**Hypothesis 8c (by race/ethnicity):**

Additional findings related to hypothesis eight: No relationship exists between math-as-less-altruistic career values and altruistic career values of high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between math-as-less-altruistic career values and altruistic career values in Caucasian high school students, r(142) = -.01, p = .47, R² = .001. However, the null hypothesis was rejected and a statistically significant positive relationship exists between altruistic career values and math-as-less-altruistic career values in Latino high school students, r(294) = .20, p = .001.

A regression analysis was used to test if altruistic career values significantly predicted math-as-less-altruistic career values in Latino high school students. The results of the regression indicated the predictor explained 4% of the variance in Latino high school students (R² = .04, R²adj. = .04, F(1, 292) = 11.97, p = .001). It was found that altruistic career values significantly predicted math-as-less-altruistic career values in Latino high school students (β = .20, p = .001).
**Hypothesis 9:**

No relationship exists between negative math values and altruistic career values of high school students.

The null hypothesis failed to be rejected and no statistically significant relationship exists between negative math values and altruistic career values in high school students, \( r(505) = -.02, p = .63, R^2 = .001 \).

**Hypothesis 9b (by gender):**

Additional findings related to hypothesis nine: No relationship exists between negative math values and altruistic career values of high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between negative math values and altruistic career values in male, \( r(269) = .01, p = .88, R^2 = .001 \), nor in female high school students, \( r(246) = -.09, p = .17, R^2 = .008 \).

**Hypothesis 9c (by race/ethnicity):**

Additional findings related to hypothesis nine: No relationship exists between negative math values and altruistic career values of high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between negative math values and altruistic career values in Caucasians, \( r(142) = -.03, p = .71, R^2 = .001 \), nor in Latino high school students, \( r(295) = -.04, p = .55, R^2 = .001 \).
Hypothesis 10:

No relationship exists between perceived math achievement and math-as-less-altruistic career values in high school students.

The null hypothesis failed to be rejected and no statistically significant relationship exists between perceived math achievement and math-as-less-altruistic career values in high school students, \( r(505) = -0.08, p = 0.07, R^2 = 0.006. \)

Hypothesis 10b (by gender):

Additional findings related to hypothesis ten: No relationship exists between perceived math achievement and math-as-less-altruistic career values in high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between perceived math achievement and math-as-less-altruistic career values in male, \( r(261) = -0.07, p = 0.25, R^2 = 0.005 \) nor in female high school students, \( r(244) = -0.09, p = 0.15, R^2 = 0.009. \)

Hypothesis 10c (by race/ethnicity):

Additional findings related to hypothesis ten: No relationship exists between perceived math achievement and math-as-less-altruistic career values in high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between perceived math achievement and math-as-less-altruistic career values in Caucasians, \( r(141) = -0.12, p = 0.17, R^2 = 0.01, \) nor in Latino high school students, \( r(285) = -0.06, p = 0.35, R^2 = 0.003. \)
Hypothesis 11:

No relationship exists between negative math values and math-as-less-altruistic career values in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between negative math values and math-as-less-altruistic career values in high school students, \( r(505) = .23, p = .001 \).

A regression analysis was used to test if negative math values significantly predicted math-as-less-altruistic career values in high school students. The results of the regression indicated the predictor explained 5% of the variance (\( R^2 = .05, R^2\text{adj.} = .05, F(1, 503) = 28.00, p = .001 \)). It was found that negative math values significantly predicted math-as-less-altruistic career values (\( \beta = .23, p = .001 \)).

Hypothesis 11b (by gender):

Additional findings related to hypothesis eleven: No relationship exists between negative math values and math-as-less-altruistic career values in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between negative math values and math-as-less-altruistic career values in both male, \( r(269) = .20, p = .001 \), and female high school students, \( r(246) = .28, p = .001 \).

Regression analyses were used to test if negative math values significantly predicted math-as-less-altruistic career values in high school students. The results of the regressions indicated the predictor explained 4% of the variance in males (\( R^2 = .04, R^2\text{adj.} = .04, F(1, 267) = 11.50, p = .001 \)) and 8% of the variance in females (\( R^2 = .08, R^2\text{adj.} = .08, F(1, 244) = 20.97, p = .001 \)). It was found that negative math values significantly predicted math-as-less-altruistic
career values both in male high school students ($\beta = .20, p = .001$) and in female high school students ($\beta = .28, p = .001$).

_Hypothesis 11c (by race/ethnicity)_:

Additional findings related to hypothesis eleven: No relationship exists between negative math values and math-as-less-altruistic career values in high school students.

The null hypothesis was rejected and a statistically significant positive relationship exists between negative math values and math-as-less-altruistic career values in both Caucasian, $r(142) = .19, p = .03$, and Latino high school students, $r(294) = .29, p = .001$.

Regression analyses were used to test if negative math values significantly predicted math-as-less-altruistic career values in high school students. The results of the regressions indicated the predictor explained 4% of the variance in Caucasians ($R^2 = .04, R^2_{adj.} = .03, F(1, 140) = 5.07, p = .03$) and 8% of the variance in Latinos ($R^2 = .08, R^2_{adj.} = .08, F(1, 292) = 25.99, p = .001$). It was found that negative math values significantly predicted math-as-less-altruistic career values both in Caucasian high school students ($\beta = .19, p = .03$) and in Latino high school students ($\beta = .29, p = .001$).

_Hypothesis 12:_

No relationship exists between internal math values and math-as-less-altruistic career values in high school students.

The null hypothesis failed to be rejected and no statistically significant relationship exists between math-as-less-altruistic career values and internal math values in high school students, $r(505) = -.07, p = .10, R^2 = .005$. 
Hypothesis 12b (by gender):

Additional findings related to hypothesis twelve: No relationship exists between internal math values and math-as-less-altruistic career values in high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between internal math values and math-as-less-altruistic career values in male, $r(269) = -.07$, $p = .25$, $R^2 = .005$ nor in female high school students, $r(246) = -.08$, $p = .21$, $R^2 = .007$.

Hypothesis 12c (by race/ethnicity):

Additional findings related to hypothesis twelve: No relationship exists between internal math values and math-as-less-altruistic career values in high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between internal math values and math-as-less-altruistic career values in Latino high school students, $r(294) = -.02$, $p = .79$, $R^2 = .001$. However, the null hypothesis was rejected and a statistically significant negative relationship exists between internal math values and math-as-less-altruistic career values in Caucasian high school students, $r(142) = -.23$, $p = .006$.

A regression analysis was used to test if internal math values significantly predicted math-as-less-altruistic career values in Caucasian high school students. The results of the regression indicated the predictor explained 5% of the variance in Caucasian high school students ($R^2 = .05$, $R^2_{adj.} = .05$, $F(1, 140) = 7.94$, $p = .006$). It was found that internal math values significantly predicted math-as-less-altruistic career values in Caucasian high school students ($\beta = -.23$, $p = .006$).
Hypothesis 13:

No relationship exists between external math values and math-as-less-altruistic career values in high school students.

The null hypothesis failed to be rejected and no statistically significant relationship exists between math-as-less-altruistic career values and external math values in high school students, $r(505) = -.04, p = .40, R^2 = .001$.

Hypothesis 13b (by gender):

Additional findings related to hypothesis thirteen: No relationship exists between external math values and math-as-less-altruistic career values in high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between external math values and math-as-less-altruistic career values in male, $r(269) = -.07, p = .28, R^2 = .004$, nor in female high school students, $r(246) = -.01, p = .93, R^2 = .001$.

Hypothesis 13c (by race/ethnicity):

Additional findings related to hypothesis thirteen: No relationship exists between external math values and math-as-less-altruistic career values in high school students.

The null hypothesis failed to be rejected thus no statistically significant relationship exists between external math values and math-as-less-altruistic career values in Latino high school students, $r(294) = .04, p = .52, R^2 = .001$. However, the null hypothesis was rejected and a statistically significant negative relationship exists between external math values and math-as-less-altruistic career values in Caucasian high school students, $r(142) = -.20, p = .02$.

A regression analysis was used to test if external math values significantly predicted math-as-less-altruistic career values in Caucasian high school students. The results of the regression indicated the predictor explained 4% of the variance in Caucasian high school
It was found that external math values significantly predicted math-as-less-altruistic career values in Caucasian high school students ($\beta = -.20$, $p = .02$).

Results for Open-ended and Other Questions

In addition to the hypotheses testing, results for open-ended and other questions are reported as descriptive measures in Tables 13-32. The following sections focus on factors least liked about math, perceptions and notions of success, career considerations and influences of family, teachers, peers, and other role models.

*What Students Enjoy Least about Math*

Overall, when asked what they enjoyed least about math, the top two reasons were the math itself and the work. That math is hard, and not understanding were the following two factors least liked about math by students.

*By gender*

While the most mentioned factor that males least liked about math was the work, for females was the math itself (see Table 13). For males, the math followed as the second most mentioned factor. That math is hard was the third most mentioned reason by both males and females; the fourth most mentioned reason was not understanding by both males and females. For males, that math is too time-consuming was mentioned as frequently as not understanding. For female students the fifth most mentioned reason was that math is too complicated.
Table 13

*Frequency of Students’ Perceptions on Least Enjoyable Characteristics About Math by Gender*

<table>
<thead>
<tr>
<th>Reason</th>
<th>Overall %</th>
<th>Males %</th>
<th>Females %</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Math</td>
<td>24</td>
<td>19</td>
<td>24</td>
</tr>
<tr>
<td>The Work</td>
<td>23</td>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>Hard</td>
<td>13</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Not Understanding</td>
<td>11</td>
<td>7</td>
<td>13</td>
</tr>
</tbody>
</table>

*By race/ethnicity*

For Latinos, the math, the work, and that math is hard, were the top three reasons given on what they liked least about math (see Table 14). For Caucasians, the top three reasons were the math, the work, and not understanding. The teacher was the fourth most mentioned factor Latino students least liked about math; for Caucasians it was that math is too complicated.

Table 14

*Frequency of Students’ Perceptions on Least Enjoyable Characteristics About Math by Race/Ethnicity*

<table>
<thead>
<tr>
<th>Reason</th>
<th>Overall %</th>
<th>Latinos %</th>
<th>Caucasians %</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Math</td>
<td>20</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>The Work</td>
<td>20</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>Hard</td>
<td>11</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Not Understanding</td>
<td>10</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Too Complicated</td>
<td>6</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>The Teacher</td>
<td>6</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>
Low Math Rate Students’ Notions of Success and the Role Teachers Play

There were some questions related directly to two different aspects of success. The first aspect is related to the academic areas students who rated themselves as low in math ability perceived they were successful in, the reasons for that success, and what role did teachers play in that success. The second part of this section deals more specifically with math success as it relates to the students’ perspectives about teachers.

Courses Low Math Rate Students Think They are Successful in, Why, and What Influence They Ascribe to Teachers.

The top four subjects low math rate students thought they were successful in were English, science, history, and math. English was the most frequent answer with half of low math rate students saying they were successful. The primary reasons given by low math rate students as to why they were successful in those courses were because they understand the class/subject, because it is interesting, and/or because it is easy. The most prominent things low math rate students perceived their teachers did to help them be successful in courses in which they did well were teach, help, and give time. Ten percent of low math rate students perceived teachers in the courses they are successful in had no influence or did not play a role in their success.

By gender

Approximately two out of three female low math rate students said they were successful in English courses, compared to one in three among low math rate males (see Table 15). One out of four low math rate students said to be successful in science regardless of gender. For low math rate male students, the third highest choice was math. For low math rate female students, the
third highest choice was history. Math came in fourth place among low math rate female students.

Table 15

*Frequency of Low Math Students’ Perceptions on Courses They Are Successful by Gender*

<table>
<thead>
<tr>
<th>Course</th>
<th>Overall %</th>
<th>Males %</th>
<th>Females %</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>51</td>
<td>38</td>
<td>63</td>
</tr>
<tr>
<td>Science</td>
<td>26</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>History</td>
<td>22</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>Math</td>
<td>19</td>
<td>21</td>
<td>25</td>
</tr>
</tbody>
</table>

*Note. Low math students comprise those students who rated themselves as C or below in math achievement.*

That they understand the subject was the top reason of success for low math rate students in classes, regardless of gender (see Table 16). More females ascribed their success in courses to the class being interesting than males. Although a class being easy was mentioned by 21% of both male and female low math rate students, for males it was the second highest reason while for females it was the third highest reason.

Table 16

*Frequency of Low Math Students’ Perceptions on Reasons for Success in Courses They Are Successful by Gender*

<table>
<thead>
<tr>
<th>Reason</th>
<th>Overall %</th>
<th>Males %</th>
<th>Females %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understandable</td>
<td>30</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td>Interest</td>
<td>24</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>Easy</td>
<td>21</td>
<td>21</td>
<td>21</td>
</tr>
</tbody>
</table>

*Note. Low math students comprise those students who rated themselves as C or below in math achievement.*
Teach, or teach right, was the top factor low math rate students perceived teachers did that helped their success, regardless of gender (see Table 17). One in every four low math rate male students and one out of every three low math rate female students said they were successful in a class in part because the teachers ‘teach’ or ‘teach well,’ ‘explain further when necessary,’ etc.

Table 17

<table>
<thead>
<tr>
<th>Top four things low math rate students perceive their teachers do to help them be successful in these courses</th>
<th>Overall</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teach</strong></td>
<td>29</td>
<td>23</td>
<td>34</td>
</tr>
<tr>
<td><strong>Help</strong></td>
<td>18</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>14</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td><strong>Encourage</strong></td>
<td>12</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td><strong>No Influence</strong></td>
<td>10</td>
<td>14</td>
<td>6</td>
</tr>
</tbody>
</table>

*Note. Low math students comprise those students who rated themselves as C or below in math achievement. The Teach category included answers such as teach, teach right, and explain as many times as necessary, among others. The Help category included the general statement of ‘helps me’ to ‘helps me with homework’ or ‘helps by providing opportunity to practice.’ In addition to the statement of ‘encourage me,’ the Encourage category included answers similar to ‘encourages me to do good.’ The Time category included answers such as ‘takes time to explain’, ‘…to explain well’, ‘patient’, and ‘gives time.’*

Help was the second most mentioned factor by low math rate students as to what they perceived their teachers did that contributed to their success, regardless of gender. The Help category included the general statements of ‘helps me,’ ‘helps me with homework’ or ‘helps by providing opportunity to practice.’
‘Gives time’ was the third most mentioned factor low math rate male students perceived a teacher did that contributed to their success in a course. For low math rate female students, the third most mentioned factor was encouragement.

Fourteen percent of low math rate male students did not think teachers in courses they were successful contributed to their success. For low math rate female students, 6% of them did not think their teachers have done anything to help them be successful in those courses they did well.

*By race/ethnicity*

Close to half of Latino low math rate students thought they were successful in English compared to almost two out of every three Caucasian low math rate students (see Table 18). Math followed science and history as the fourth most mentioned subject in which low math rate students perceived they were successful, with 15% of Latinos and 20% of Caucasian low math rate students.

<table>
<thead>
<tr>
<th>Course</th>
<th>Overall %</th>
<th>Latinos %</th>
<th>Caucasians %</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>50</td>
<td>48</td>
<td>62</td>
</tr>
<tr>
<td>Science</td>
<td>26</td>
<td>26</td>
<td>35</td>
</tr>
<tr>
<td>History</td>
<td>22</td>
<td>19</td>
<td>33</td>
</tr>
<tr>
<td>Math</td>
<td>18</td>
<td>15</td>
<td>20</td>
</tr>
</tbody>
</table>

*Note.* Low math students comprise those students who rated themselves as C or below in math achievement. Latino (n = 170), Caucasians (n = 55), Overall (n = 260) includes African Americans, Native Americans, Asian/Pacific Islanders, in addition to Latinos and Caucasians.
That they understand the subject, that it is interesting, and that it is easy were the top reasons low math rate students ascribed to being successful in a class, for both Latinos and Caucasians (see Table 19).

Table 19

*Frequency of Low Math Students’ Perceptions on Reasons for Success in Courses They Are Successful by Race/Ethnicity*

<table>
<thead>
<tr>
<th>Top three reasons why low math rate students perceive they are successful in these courses</th>
<th>Overall</th>
<th>Latinos</th>
<th>Caucasians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reason</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Understandable</td>
<td>30</td>
<td>27</td>
<td>35</td>
</tr>
<tr>
<td>Interest</td>
<td>24</td>
<td>23</td>
<td>31</td>
</tr>
<tr>
<td>Easy</td>
<td>22</td>
<td>24</td>
<td>15</td>
</tr>
</tbody>
</table>

*Note.* Low math students comprise those students who rated themselves as C or below in math achievement. Latino (n = 170), Caucasians (n = 55), Overall (n = 260) includes African Americans, Native Americans, Asian/Pacific Islanders, in addition to Latinos and Caucasians.

Teach, or teach right, was the top factor low math rate students perceived teachers did that helped their success, for both Caucasians and Latinos (see Table 20). Help was the second most mentioned factor by Latino low math rate students as to what they perceived their teachers did that contributed to their success. For Caucasians, time and encouragement tied for the second most mentioned reason; help was the fourth most mentioned for Caucasians. ‘Gives time’ was the third most mentioned factor Latino low math rate students perceived a teacher did that contributed to their success in a course, followed by encouragement.

Eleven percent of Latino and 9% of Caucasian low math rate students did not think teachers in courses they were successful did anything to help them be successful in those courses.
Table 20

Frequency of Low Math Students’ Perceptions on Teachers’ Influence for Success in Courses They Are Successful by Race/Ethnicity

<table>
<thead>
<tr>
<th>Action</th>
<th>Overall</th>
<th>Latinos</th>
<th>Caucasians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teach</td>
<td>28</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td>Help</td>
<td>18</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>Time</td>
<td>14</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Encourage</td>
<td>12</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>No Influence</td>
<td>10</td>
<td>11</td>
<td>9</td>
</tr>
</tbody>
</table>

Note. Low math students comprise those students who rated themselves as C or below in math achievement. Latino (n = 170), Caucasians (n = 55), Overall (n = 260) includes African Americans, Native Americans, Asian/Pacific Islanders, in addition to Latinos and Caucasians. The Teach category included answers such as teach, teach right, and explain as many times as necessary, among others. The Help category included the general statement of ‘helps me’ to ‘helps me with homework’ or ‘helps by providing opportunity to practice.’ In addition to the statement of ‘encourage me,’ the Encourage category included answers similar to ‘encourages me to do good.’ The Time category included answers such as ‘takes time to explain’, ‘…to explain well’, ‘patient’, and ‘gives time.’

Math Success and Teachers

The majority of students (63%) who rated themselves as high in math achievement thought their math teachers care about their success in math; half of the students who rated themselves as C or lower in math achievement thought likewise (see Table 21). One in four high math rate students as well as one in three low math rate students remained neutral as to whether their math teachers care about their success in math.

When asked if their math teachers take little interest in their success in math, the percentage remained similar for high math rate students when asked the question in a positive way. However, the percentage for low math rate students dropped to 39% when the question was asked in the negative, compared to 47% when asked in the positive. Of high math rate students, 30% remained neutral when the question about teachers caring for their math success was asked in the negative; 47% of low math rate students did the same.
Table 21

Frequency of Students’ Perceptions on Teachers’ Caring And Interest for Their Success in Math by Perceived Math Achievement

<table>
<thead>
<tr>
<th>Strongly Agree/Agree</th>
<th>Neutral</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>My math teacher cares about my success in math</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>69% of high math students</td>
<td>24% of high math students</td>
<td>8% of high math students</td>
</tr>
<tr>
<td>47% of low math students</td>
<td>36% of low math students</td>
<td>17% of low math students</td>
</tr>
<tr>
<td><strong>My teachers take little interest in my success in math</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10% of high math students</td>
<td>30% of high math students</td>
<td>60% of high math students</td>
</tr>
<tr>
<td>14% of low math students</td>
<td>47% of low math students</td>
<td>39% of low math students</td>
</tr>
<tr>
<td><strong>My math teacher won’t let me fail</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55% of high math students</td>
<td>29% of high math students</td>
<td>15% of high math students</td>
</tr>
<tr>
<td>43% of low math students</td>
<td>32% of low math students</td>
<td>24% of low math students</td>
</tr>
</tbody>
</table>

*Note.* High math students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.

More than half (55%) of students who rated themselves as high in math achievement thought their math teacher will not let them fail compared to 43% of students who rated themselves as C or lower in math achievement (see Table 21). However, one out of four low math rate students thought their math teacher would let them fail, compared to only 15% of high math rate students.

Career Considerations: STEM Careers and Others’ Influence on Career Choice

There were some questions related directly to two areas of career considerations. The first area is related to influences specific to science/math career considerations. The second part of this section deals with other people’s influence on students’ career choice in general.

*Influences on Math/Science Career Considerations*

Of all students surveyed, 47% specifically stated that they were not choosing a career in science or math. Of those students who did state a desire to choose a career in science or math,
what they enjoyed most about it was the science/math itself, to learn and discover, to solve problems, and they enjoyed the challenge the chosen career presented.

**By gender**

When looked at by gender, 44% of all males surveyed and 49% of all females specifically expressed that they were not choosing a career in science or math. Among students who were choosing a career in science or math, there does not seem to be any difference by gender with respect to the top aspects they enjoyed most about a science or math career (see Tables 22 and 23).

### Table 22

*Frequency of Students’ Reasons for Liking a Science/Math Career by Gender*

<table>
<thead>
<tr>
<th>Reason</th>
<th>Overall</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Science</td>
<td>12</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>To Learn/Discover</td>
<td>11</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>The Math</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

### Table 23

*Frequency of Students’ Reasons for Liking a Science/Math Career by Gender (Without the Math/the Science)*

<table>
<thead>
<tr>
<th>Reason</th>
<th>Overall</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Learn/Discover</td>
<td>11</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>To Solve Problems</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>The Challenge</td>
<td>8</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>
**By race/ethnicity**

When looked at by race/ethnicity, 46% of all Latinos surveyed and 46.5% of all Caucasians specifically expressed that they were not choosing a career in science or math. Among students who were choosing a career in science or math, there does not seem to be any difference by gender with respect to the top aspects they enjoyed most about a science or math career (see Table 24).

Table 24

*Frequency of Students’ Reasons for Liking a Science/Math Career by Race/Ethnicity*

<table>
<thead>
<tr>
<th>What do students who are choosing a career in science or math enjoy most about it?</th>
<th>Overall</th>
<th>Latinos</th>
<th>Caucasians</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Science</td>
<td>24</td>
<td>25</td>
<td>21</td>
</tr>
<tr>
<td>To Learn/Discover</td>
<td>19</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>To Solve Problems</td>
<td>19</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>The Math</td>
<td>18</td>
<td>16</td>
<td>17</td>
</tr>
</tbody>
</table>

*Note: Overall includes African Americans, Native Americans, Asian/Pacific Islanders, in addition to Latinos and Caucasians*

However, there is a difference in terms of ordering of those aspects. Namely, for Latinos the aspects were, ordered from most mentioned to least mentioned, the science itself, to learn/discover, to solve problems, and the math itself; for Caucasians the order was to solve problems, the science itself, to learn/discover, and the math. When excluding the math and the science, to learn/discover was the top aspect they most enjoyed about a science or math career; for Caucasians the top aspect was solving problems (see Table 25).
Table 25

*Frequency of Students’ Reasons for Liking a Science/Math Career by Race/Ethnicity (Without the Math/the Science)*

<table>
<thead>
<tr>
<th>Reason</th>
<th>Overall %</th>
<th>Latinos %</th>
<th>Caucasians %</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Learn/Discover</td>
<td>19</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>To Solve Problems</td>
<td>19</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>The Challenge</td>
<td>15</td>
<td>16</td>
<td>13</td>
</tr>
</tbody>
</table>

*Note: Overall includes African Americans, Native Americans, Asian/Pacific Islanders, in addition to Latinos and Caucasians*

Of students who rated themselves as high in math achievement, one of three stated their parents were influencing them to a science/math career, compared to only 13% of students who rated themselves as C or below in math achievement (see Table 26). One third of high math rate students thought their parents were not influencing them to a science/math career; one half of low math rate students did not think parents were influencing them to a career in science or math. Also, one out of three students did not have an opinion on whether their parents were influencing them to a career in science or math, regardless of perceived math achievement.

When asked if their teachers were influencing them to a science/math career, one of three high math rate students thought their teachers were indeed influencing them to a science/math career, compared to 14% of low math rate students (see Table 26). One out of every four high math rate students thought their teachers were not influencing them to a science/math career; half of low math rate students did not think their teachers were influencing them to a science/math career. Regardless of perceived math achievement, two out of every five students had no opinion on whether their teachers were influencing them to a science/math career.
As shown in Table 26, 42% of high math rate students thought they had strong role models in science/math compared to 22% of low math rate students. The percentage of low math rate students who said they did not have strong role models in science/math more than doubled that of high math rate students who thought the same. Two out of every five students remained neutral on whether they had strong science/math role models, regardless of perceived math achievement.

Forty-five percent of high math rate students said that a career in math is in high demand compared to 22% of low math rate students (see Table 27). The percentage of low math rate students who thought a math career is not in high demand more than doubled the percentage of high math rate students who thought likewise. One out of every three students did not have an opinion, regardless of perceived math achievement.
Table 27

*Frequency of Students’ Perceptions About Demand and Esteem of a Science/Math Career by Perceived Math Achievement*

<table>
<thead>
<tr>
<th>Strongly Agree/Agree</th>
<th>Neutral</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A career in math is in high demand</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45% of high math students</td>
<td>35% of high math students</td>
<td>20% of high math students</td>
</tr>
<tr>
<td>22% of low math students</td>
<td>34% of low math students</td>
<td>44% of low math students</td>
</tr>
<tr>
<td><strong>A career in science or math is held in high esteem by society</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43% of high math students</td>
<td>49% of high math rate students</td>
<td>8% of high in math students</td>
</tr>
<tr>
<td>25% of low math students</td>
<td>53% of low math students</td>
<td>22% of low math students</td>
</tr>
</tbody>
</table>

*Note. High math students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.*

Is a science/math career held in high esteem by society? As shown in Table 27, 43% of high math rate students thought so, compared to 25% of low math rate students. Eight percent of high math rate students said they did not think a science/math career is held in high esteem by society; 22% of low math rate students did not think a science/math career is held in high esteem by society. Half of the students did not have an opinion either way, regardless of perceived math achievement.

Of students who rated themselves as high in math achievement, 45% said a career in science allows for teaming up with highly motivated people; 41% remained neutral on whether a science careers provided them an opportunity to team up with highly motivated people (see Table 28). Forty-two percent of students who rated themselves as C or lower in math also remained neutral. Twenty-nine percent of low math rate students said a science career does allow for teaming up with highly motivated people, while the same percentage said a science career does not allow for that.
More than half of students said they did not want a career in a lab setting, regardless of perceived math achievement (see Table 28). Only 13% of both high and low math rate students wanted a career in a lab setting. One out of every three students remained neutral as to whether they wanted a career in a lab setting, regardless of perceived math achievement.

Table 28

Frequency of Students’ Perceptions on Miscellaneous Career Interests by Perceived Math Achievement

<table>
<thead>
<tr>
<th>Strongly Agree/Agree</th>
<th>Neutral</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>A career in science allows me to team with highly motivated people</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45% of high math students</td>
<td>41% of high math students</td>
<td>13% of high math students</td>
</tr>
<tr>
<td>29% of low math students</td>
<td>42% of low math students</td>
<td>29% of low math students</td>
</tr>
<tr>
<td>I want a career in a laboratory setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13% of high math students</td>
<td>33% of high math students</td>
<td>55% of high math students</td>
</tr>
<tr>
<td>13% of low math students</td>
<td>30% of low math students</td>
<td>57% of low math students</td>
</tr>
<tr>
<td>My peers have chosen other careers that seem more interesting and challenging</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14% of high math students</td>
<td>61% of high math students</td>
<td>25% of high math students</td>
</tr>
<tr>
<td>21% of low math students</td>
<td>60% of low math students</td>
<td>19% of low math students</td>
</tr>
</tbody>
</table>

Note. High math students comprise those students who rated themselves as A or B in math achievement. Low math students comprise those students who rated themselves as C or below in math achievement.

Most students (3/5) had no opinion on whether their peers had chosen a more interesting/challenging career (see Table 28). One of four high math students said they thought their chosen career was more interesting than the careers chosen by peers; 19% of low math rate students thought so too. Only 14% of high math rate students thought their peers had chosen more interesting/challenging careers; 21% of low math rate students thought the same.
Others’ Influence on Students’ Career Choice

Forty-seven percent of participants expressed that either there was not a person who had significantly impacted their career choice or that it was a decision made without anybody else’s influence (see Table 29). Of those who did acknowledge another person’s influence on their career choice, the things these people did to impact their career choice were very varied. One of the most frequently mentioned things by students that a person did to significantly impact their career choice was encouragement. Within this category, some of the students’ expressions were that these influential people ‘encouraged me to give my best effort,’ or that the person ‘encouraged me by telling me that I can do it,’ or ‘that I can be successful,’ for example. Another thing a person did to significantly impact a student’s career choice was by showing them that they would enjoy the career.

Table 29

Frequency of Students’ Perceptions on Others’ Influence on Career Choice by Gender

If a person has significantly impacted a student’s career choice, what did that person do that had such a strong influence on them?

<table>
<thead>
<tr>
<th>Reason</th>
<th>Overall %</th>
<th>Males %</th>
<th>Females %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encouragement</td>
<td>8</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Enjoyment of Career</td>
<td>7</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Teach/Show</td>
<td>5</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Personal Qualities</td>
<td>5</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>No Outside Influence</td>
<td>47</td>
<td>49</td>
<td>45</td>
</tr>
</tbody>
</table>
By gender

When analyzed by gender, of all students who mentioned that being taught about the career by someone had a significant impact in their career choice 69% were males (see Table 29). Of those who mentioned personal qualities as having a significant impact on their career choice, 68% were female. Of those who mentioned that what a person did to impact their career choice was to be the first in the family to graduate from high school or college 69% were male. Of those who said that a person cared, 71% were male. Of those who mentioned that what a person did to impact their career choice was to make them aware of the benefits of a career (e.g., working conditions, freedom/independence, status, recognition, respectability), 82% were female. Of those who mentioned that what a person did to impact their career choice was to make them aware of the potential a career has to help other people, 88% were female. Forty-nine percent of all male participants said no one had influenced their career choice, 45% of all female participants said the same.

By race/ethnicity

When analyzed by race/ethnicity, of all students who mentioned that receiving encouragement had a significant impact on their career choice 69% were Latino, 18% Caucasian (see Table 30). Of those who mentioned that what a person did to impact their career choice was communicate the enjoyment of the career, 69% were Latino, 17% were Caucasian. Of those who said that being taught about the options or possibilities of the career by someone had a significant impact on their career choice 74% were Latinos, 22% Caucasian. Of those who mentioned that what a person did to impact their career choice was to communicate the financial benefits of the career, 88% were female Latino, 12% Caucasian. Of those who mentioned that what a person did to impact their career choice was to help them, 77% were Latino, 8% Caucasian.
Table 30

*Frequency of Students’ Perceptions on Others’ Influence on Career Choice by Race/Ethnicity*

If a person has significantly impacted a student’s career choice, what did that person do that had such a strong influence on them?

<table>
<thead>
<tr>
<th>Reason</th>
<th>Overall</th>
<th>Latinos</th>
<th>Caucasians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encouragement</td>
<td>15</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Enjoyment of Career</td>
<td>13</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Teach/Show</td>
<td>10</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Personal Qualities</td>
<td>9</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>No Outside Influence</td>
<td>48</td>
<td>44</td>
<td>54</td>
</tr>
</tbody>
</table>

*Note: Latinos (n = 294), Caucasians (n = 142), Overall (n = 507) includes African Americans, Native Americans, Asian/Pacific Islanders, in addition to Latinos and Caucasians.*

Of those who mentioned that what a person did to impact their career choice was be the first in the family to graduate from high school or college 92% were Latino; no Caucasians mentioned this as a factor. Of those who said that what a person did was care, 71% were Latino, 14% Caucasian. Of those who mentioned that what a person did to impact their career choice was to make them aware of the benefits of a career (e.g., working conditions, freedom/independence, status, recognition, respectability), 73% were Latino, 9% Caucasian. Of those who mentioned that what a person did to impact their career choice was to make them aware of the potential a career has to help other people, 38% were Caucasian, 63% were Latino. Fifty-four percent of all Caucasian participants said no one had influenced their career choice, 44% of all Latino participants said the same.

*Who Significantly Impacts Students’ Career Choice?*

Students’ responses to this question were further examined in an attempt to identify the relationship of the people who had significantly impacted their career choice. Only about 49% of the answers had a clearly identifiable relationship. Of those who did specify a relationship, family was by far the top answer followed by teachers, other, and friends (see Table 31).
Table 31

*Frequency of Students’ Relations Who Have Influenced Their Career Choice by Gender*

<table>
<thead>
<tr>
<th>Relation</th>
<th>Overall %</th>
<th>Males %</th>
<th>Females %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>63</td>
<td>67</td>
<td>61</td>
</tr>
<tr>
<td>Teachers</td>
<td>24</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>Friends</td>
<td>5</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>13</td>
<td>4</td>
</tr>
</tbody>
</table>

*Note.* Males (n = 61), Females (n = 70), Overall (n = 131).

**By gender**

When it comes to career choice, a great majority of students who specified a relationship identified a family member as the person who had a significant impact on their career choice, regardless of gender but a greater percentage of males naming family than females (see Table 31). Teachers were the second most mentioned relationship for both males and females, but females mentioning teachers at a higher percentage than males. When it comes to friends, no males specifically identified a friend as a person who had a significant impact. On the other hand, 10% of females specifically mentioned a friend as having a significant impact. Other people had a greater impact on males’ career choice than friends.

**By race/ethnicity**

A great majority of both Latino and Caucasian students who specified a relationship identified a family member as the person who had a significant impact on their career choice (see Table 32). Teachers were the second most mentioned relationship for both Latinos and Caucasians, but the percentage of Latinos mentioning teachers almost doubled that of Caucasians. Only 1% of Latinos specifically identified a friend as a person who had a significant impact.
impact on their career choice whereas 13% of Caucasians specifically mentioned a friend as having a significant impact.

Table 32

<table>
<thead>
<tr>
<th>Relation</th>
<th>Overall %</th>
<th>Latinos %</th>
<th>Caucasians %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family</td>
<td>63</td>
<td>63</td>
<td>60</td>
</tr>
<tr>
<td>Teachers</td>
<td>24</td>
<td>30</td>
<td>16</td>
</tr>
<tr>
<td>Friends</td>
<td>5</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>6</td>
<td>11</td>
</tr>
</tbody>
</table>

Note. Latinos (n = 70), Caucasians (n = 45), Overall (n = 131) includes African Americans, Native Americans, Asian/Pacific Islanders, in addition to Latinos and Caucasians.
CHAPTER FIVE

Discussion and Recommendations

The purpose of this study has been to examine high school students’ values about math, perceived math achievement, and STEM career choice.

The critical need for STEM education in the United States has been well established (e.g., Board on Science Education, 2011; Emdin, 2011; Lauriski-Karriker et al., 2011). The U.S. economic development has become increasingly dependent on STEM-related professions (e.g., ESA, 2011; He, 2007; Lindholm-Leary & Borsato, 2003; Oliver, 2011a, 2011b; Reiss, 2012). Based on projections, the demand for STEM skills is greater than the supply. Added to this picture is the historical underrepresentation of females and ethnic/racial minority groups in these fields (BSE, 2011; Cole & Espinoza, 2008; Lindholm-Leary & Borsato, 2003; National Center for Education Statistics, 2001; National Science Board, 2012). But the U.S. population is increasingly becoming more heterogeneous, with racial/ethnic minorities a greater percentage in the total population (Girves et al., 2005; Gregory, 2003; Lane, 2001; Lindholm-Leary & Borsato, 2003). Potentially, there may be a greater representation of non-Caucasian ethnic groups in the higher education student population and workforce. On the other hand, fewer males are pursuing a higher education path while the representation of females has increased, albeit not necessarily in the STEM fields, or at least not at an increased pace (Blue et al., 2005, Hoff-Sommers, 2000; Roenigk, 2011; Tabarrok, 2012).

All these factors lead to a picture of concern; more people are needed with STEM skills than there are people to provide them (Gunderson, Ramirez, Levine, et al., 2012; Oliver, 2011b). Furthermore, women “select out of STEM degrees at a greater rate than do men” (Lauriski-
Karriker et al., 2011, p.1). In general, 40% of U.S. STEM freshmen switch majors and “fewer STEM students are graduating than non-STEM students” (Weiford, 2012). Moreover, the populations that can provide that need are not being engaged to potentially facilitate the desired supply to meet the needed skills to safeguard the optimal development of the Nation’s future success and prosperity (BSE, 2011).

Numerous efforts and resources have been employed to examine issues about STEM education and improve recruitment and retention (De Welde et al., 2007; Ermer, 2004; Kelly, 2006; Ketcham et al., 2005; Sonnert & Holton, 1995; also see National Science Foundation, 2012b). There is still much to be examined however regarding the successful development, recruitment and retention to the STEM disciplines, of all students, racial/ethnic minorities, women, and men. Though females’ perceived ability has been a priority, males’ situation is as worrisome (Jacobs et al., 2002). Jacobs et al. (2002) argued that males lag behind females in academic achievement (e.g., Marsh & Yeung, 1998). Males’ poor math values and achievement makes them likely candidates to dropout out of school or select other fields. Hoff Sommers (2000) reported male student are generally less academically engaged and less likely to attend college. Currently, males comprise only 43% of the college population and their representation is expected to decrease (Gerald & Hussar, 2000 in Jacobs et al., 2002). Efforts must be made to address males’ declining academic values and success without neglecting females (Dotterer et al., 2009). This study is intended to contribute to the body of knowledge, the discussion and assessment of this problem with a particular emphasis on mathematics, and with the consideration of gender and race/ethnicity as factors. More specifically, the purpose of this study has been to examine high school students’ values about math, perceived math achievement, and STEM career choice.
Sample Composition

The overall sample consisted of 515 high school students of which 505 provided a self-rating of their math achievement: (52% male [n=269]; 48% female [n=246]). The majority of participants (n=294) were Latinos, followed by Caucasians (n=142), Native Americans (n=27), Asian/Pacific Islanders (n=7), and African Americans (n=4); 7% of participants selected the category of Other (n=33) (see Figure 1). The number of students self-identified as Native American, Asian/Pacific Islander, African American, and Other Race/Ethnicity were too few to analyze. Participants (n=512) also identified their academic grade level (see Figure 2).

*Figure 1. Distribution by Race/Ethnicity*  
*Figure 2. Overall Distribution by Grade*
One half of the students (53%, n=265) perceived their math achievement as C or lower, while 47% (n=240) rated themselves as B or higher in math. Overall, 8% of students (n=41) perceived themselves as A in math achievement, 39% as B (n=199), 38% as C (n=190), 11% as D (n=55), and 4% as F (n=20). As shown in Figure 3, more than half of students who rated themselves as C or lower in math were female. Of students who perceived themselves as B or higher in math, 57% was male. Less than half of females self-rated as high in math achievement while 51% of males rated themselves as high in math achievement (see Figure 4). Less than 5% of females perceived themselves as A in math, compared to 11% of males.

*Figure 3. Low and High Math Self-Rating by Gender*

<table>
<thead>
<tr>
<th>Low Math Self-Rating by Gender</th>
<th>High Math Self-Rating by Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Males</strong> n=125&lt;br&gt;47%</td>
<td><strong>Females</strong> n=140&lt;br&gt;53%</td>
</tr>
<tr>
<td><strong>Females</strong> n=140&lt;br&gt;53%</td>
<td><strong>Males</strong> n=136&lt;br&gt;57%</td>
</tr>
</tbody>
</table>

*Figure 4. Females and Males Math Self-Rating*

<table>
<thead>
<tr>
<th>Females Math Self-Rating</th>
<th>Males Math Self-Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>A n=11&lt;br&gt;5%</td>
<td>A n=30&lt;br&gt;11%</td>
</tr>
<tr>
<td>C or below n=140&lt;br&gt;57%</td>
<td>B n=125&lt;br&gt;48%</td>
</tr>
<tr>
<td>B n=93&lt;br&gt;38%</td>
<td>B n=106&lt;br&gt;40%</td>
</tr>
</tbody>
</table>
Of students who rated themselves as low in math achievement, Latinos were the majority while they were less than half of those who rated themselves as high in math achievement (see Figure 5). Caulcasions (61%, n=86) rated themselves as high in math achievement in a greater proportion than Latinos (39%, n=115). Conversely, Latinos (58%, n=170) rated themselves as low in math achievement in a greater proportion than Caulcasions (39%, n=55). Latino high school students rated themselves as C, D, or F in math in greater percentages than Caulcasions (see Figure 6).

**Figure 5. Low and High Math Self-Rating by Race/Ethnicity**

<table>
<thead>
<tr>
<th>Low Math Self-Rating by Race/Ethnicity</th>
<th>High Math Self-Rating by Race/Ethnicity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Others</strong></td>
<td><strong>Others</strong></td>
</tr>
<tr>
<td>n=35</td>
<td>n=36</td>
</tr>
<tr>
<td>13%</td>
<td>15%</td>
</tr>
<tr>
<td><strong>Latinos</strong></td>
<td><strong>Latinos</strong></td>
</tr>
<tr>
<td>n=170</td>
<td>n=115</td>
</tr>
<tr>
<td>65%</td>
<td>49%</td>
</tr>
<tr>
<td><strong>Caucasians</strong></td>
<td><strong>Caucasians</strong></td>
</tr>
<tr>
<td>n=55</td>
<td>n=86</td>
</tr>
<tr>
<td>21%</td>
<td>36%</td>
</tr>
</tbody>
</table>

**Figure 6. Latino and Caucasian Math Self-Rating**

<table>
<thead>
<tr>
<th>Latino Math Self-Rating</th>
<th>Caucasian Math Self-Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>F</strong></td>
<td><strong>F</strong></td>
</tr>
<tr>
<td>n=15</td>
<td>n=0</td>
</tr>
<tr>
<td>5%</td>
<td>7%</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td><strong>D</strong></td>
</tr>
<tr>
<td>n=37</td>
<td>n=9</td>
</tr>
<tr>
<td>13%</td>
<td>6%</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td><strong>C</strong></td>
</tr>
<tr>
<td>n=118</td>
<td>n=46</td>
</tr>
<tr>
<td>41%</td>
<td>35%</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td><strong>B</strong></td>
</tr>
<tr>
<td>n=96</td>
<td>n=66</td>
</tr>
<tr>
<td>34%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>A</strong></td>
<td><strong>A</strong></td>
</tr>
<tr>
<td>n=19</td>
<td>n=20</td>
</tr>
<tr>
<td>7%</td>
<td>9%</td>
</tr>
</tbody>
</table>

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Summary of Results

Research has typically examined the issue of math achievement by considering math anxiety and attitudinal factors, self-efficacy, as well as parents,’ teachers,’ peers,’ and other cultural components (e.g., He, 2007; Lauriski-Karriker et al., 2011; Lindholm-Leary & Borsato, 2003; Long, Monoi, Harper, Knoblauch, & Murphy, 2007; Schenkel, 2009). In this exploratory study however, the main framework is one of external and internal math values in relation to perceived math achievement (see Figure 7). Internal math values are an individual’s feelings, perception, and beliefs about math. Namely, internal math values are an individual’s appreciation for her/his math ability and interest. External math values, on the other hand, are an individual’s feelings, perception, and beliefs about what others expect, feel, perceive, and believe about that individual’s math abilities as well as their support to that individual’s success. In other words, external math values are the values an individual perceives others hold about her/him. External math values become internalized and influence an individual’s internal math values. In addition, negative math values were also analyzed as a way to help illustrate the constructs of external and internal math values as they relate to perceived math achievement. Negative math values included items such as ‘I am not as good as math as my peers,’ and ‘My teachers take little interest in my success in math.’ Based on the results, math values (i.e., external, internal, and negative) proved to be an applicable framework; the more positive one’s math values, better perceived math achievement.

Added to the framework were two career components (see Figure 7). One component related to altruistic career values in general. To measure altruistic career values, items such as ‘I want a career in an area that directly helps people,’ ‘…impacts planet sustainability,’ and ‘…impacts societal issues’ were assessed. The other component examined in the framework was
specifically math-related; the perception of a math career as less altruistic than a non-math career (e.g., ‘I see other careers than math as benefiting people more directly,’ ‘...having more impact on societal issues,’). There were several relationships examined as it relates to the career components: 1) math values (i.e., external, internal, and negative) to altruistic career considerations, 2) math values (i.e., external, internal, negative) to the perception of math as a less altruistic career, 3) perceived math achievement to altruistic career values and to the perception of math-as-a-less-altruistic-career, and 4) altruistic career values to the perception of math-as-a-less-altruistic-career.

The framework of external and internal math values as they related to altruistic career values proved to be pertinent. What a person believes about his/her math ability, for example, is influenced by that person’s perception of what others believe about his/her math ability. These values about math influence a person’s altruistic career values; the more favorable an individual’s math values (both external and internal), the more altruistic career values that individual will have.

With regards to math as a less altruistic career, external and internal math values proved only applicable to Caucasian high school students, as can be seen in Figure 7’s dotted lines. Caucasians with positive math values are less likely to perceive that a math career is less altruistic than a non-math career. Perceived math achievement did not have a significant influence on the career components; an individual’s perception of his/her math achievement does not have a significant effect on his/her altruistic career values and career choice. As shown in Figure 7, the framework’s component of negative math values as related to math as a less altruistic career proved significant. Namely, the more negative a person’s math values, the more likely that person will view a math career as less altruistic than a non-math career.
Figure 7. Conceptual Framework of Statistically Significant Factors

- Solid arrow: Significant regardless of gender or race/ethnicity
- Dashed arrow: Significant only for Caucasians
- Dotted arrow: Significant only for males and Latinos
Altruistic career values as related to math as a less altruistic career proved to be a significant component of the framework though only applicable for males and for Latinos as shown by the broken line from altruistic career values to math-as-a-less-altruistic career in Figure 7.

Math Values and Perceived Math Achievement

An individual’s perception about what others feel and believe about that her/him with regards to mathematics (i.e., external math values) affects that individual’s own values about math (i.e., internal math values). In turn, math values affect and individual’s perceived math achievement. For instance, if others say I am good at math, it is probable that I will think I am good at math, and more likely that I perceive to have good math achievement. In contrast, negative math values affect an individual’s perception about her/his math achievement. The less positive my beliefs and feelings about math, the more likely I am to think I cannot achieve an optimal level of math competency. It is for this reason that positive encouragement is an integral component in fostering positive values about math in students. Although this understanding may seem self-evident, it is important to understand its implications and complexity in order to devise and implement sound pedagogical practices.

A vital aspect to consider is how early individuals begin to receive, interpret, and internalize these cues about math. At what age and academic stage do individuals begin to acquire and form values about math? And what type of encouragement should be given to students? Should there be a gender-based approach to promote the STEM disciplines; a race/ethnicity-based approach? Furthermore, should all students be expected to excel in science, technology, engineering, and math? Should all students be encouraged and expected to become mathematicians and engineers?
High math students tend to become aware of being good at math early on in their academic process. Low math students tend to become aware of the difficulty math presents to them later on in their academic process.

At what academic stage do students begin to acquire and form values about math? Programs that have looked to recruit students to STEM have increasingly turned from an approach of targeting high school students to engaging students at earlier stages (Baker, Rieg, & Clendaniel, 2006; BSE, 2011; Lauriski-Karriker et al., 2011; Sorby & Schumaker-Chadde, 2007), as early as elementary school, with substantial success (Ferrante, 2012; National Science Foundation, 2012a). In general, children learn early on they are good in something, music, sports, reading, and math (Eccles et al., 1993; Meece et al., 2006; Oliver, 2011a, 2011b; Roegnigk, 2011). They receive praise and good feedback. It is not surprising in this study that most high school students who perceived themselves as high in math achievement indicated an awareness of being good at math at the elementary school stage at around 11 years old for both females and males (the average age was 10 years old for males only with regards to when they were made aware by their parents).

Interestingly low-math rate students said that they realized much later in middle or high school that math was difficult for them (approximately at 13 years of age for both males and females); so these students also thought that they were good at math during elementary school. Their perceptions were much different as to when they felt that their performance was not optimal. This finding seems to suggest that elementary teachers may be doing a good job of helping students feel successful and to think they are successful, even if they perceive their grades are not A’s. Students may be forming their perceptions about math already in the earlier stages of their academic experience (e.g., Gunderson, Ramirez, Levine, et al., 2012; Lafortune et
al., 1999). It is understandable then, that positive math experiences early on may favorably affect an individual’s values about math. At the middle school level perceptions change as teachers are specialists in math. Some students in this study perceived that many of their math teachers were unable to help them feel that they were successful (Schenkel, 2009). At times college faculty blame elementary school teachers for students not knowing math when they get to high school (e.g., Koebler, 2012). However, there may be several reasons. One explanation given is that the great majority of elementary school teachers acquire their teaching certificate with little math preparation (UChicago News, 2010). Another reason is that perhaps elementary teachers are doing a good job of teaching basic material. Perhaps the change occurs at the middle school level when the introduction of math specialists affects students’ perceptions of their ability. Students’ views may also be affected by their changes in the routine of their school day in middle schools. They move from classroom to classroom and change teachers. This change also occurs during the vulnerable puberty years when adolescents are more emotional and negative math attitudes become heightened (Cheung, 1988; Lafortune et al., 1999).

Some studies examined the effects of transition from elementary school to middle school compared to the K-8 system. For example, Williams et al. (2010) found no strong association between school grade configuration and student achievement on standards-based tests. However, West and Schwerdt (2012) found that students who attended a middle school achieved at lower math levels than students who attended a school employing a K-8 system. Given that many students will come to realize the difficulty that math presents to them later in their academic experience, the findings of this study suggest a potential for negative consequences on those students as they are faced with: 1) the perception of a less welcoming and supportive environment (BSE, 2011), 2) more complex concepts presented in a manner that may counter

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earlier pedagogical strategies about math, oftentimes taught by inexperienced teachers who lack necessary resources (Board of Science Education, 2011; National Science Board, 2012), and 3) their higher achieving peers, who struggle less and may have received positive encouragement and awareness from an earlier age. In most cases these factors may contribute to a math apathy or even an aversion effect on low-math rate students. These negative effects may be more pronounced for females and racial/ethnic minorities. For example, Lindholm-Leary & Borsato (2003) stated that middle school students, “especially minority and female students, develop an aversion toward mathematics, resulting in enrollment in the fewest courses possible at middle and high school levels” (p.1). While the majority of those who first perceived being good at math in elementary were male, it is important to note that, of students who did become aware of the difficulty of math in their elementary years, even though these were a minority, the majority of them were female. Thus, females may be at a greater disadvantage since their values about math may be less favorable from an earlier stage than males, possibly internalizing an aversion for math that may be more difficult to address once they have reached the later stages of their academic careers.

*Factors Students Least Enjoy About Math: The Math Itself*

The most common answer by students when asked what they least enjoyed about math was the math itself. This distaste for math may even prevent individuals from considering further study if it requires some math courses (Lindholm-Leary & Borsato, 2003). Females in particular seemed to be averse to the math itself at a higher percentage than males; 24% of females compared to 19% of males. Females’ perceived math achievement was more susceptible to negative math values, perhaps even from an earlier academic stage, than males given that
Math is too hard

The findings of this study seem to corroborate the notion that students think that math is too much work, too hard, too time-consuming and too complicated (e.g., Drew, 2011). However, some have questioned whether students really avoid hard work or perhaps students are more “put off by any kind of work that does not appear to be worth the effort” (Talbert, 2011). Though there was not much difference by gender on these reasons, other reasons may be worthy of further exploration as some were predominantly considered by males while others by females. For example, 75% of the students who said that the least they like about math is that it is boring were male; 75% of those who mentioned frustration were female; 87% of those who said that math is not important were female; 67% of those who said the least they like about math is that it is too easy were male. Interestingly, of those who said that there was nothing they did not like about math, 91% were male.

When examined by race/ethnicity, the two most mentioned factors of what they least enjoyed about math, the math itself and the work, were the same for both Latinos and Caucasians, the third most mentioned factor may indicate a difference: for Latinos they perceived math as too hard; yet Caucasians perceived that they did not understand math. As suggested by He (2007), perhaps more than racial/ethnic differences, it may be more a matter of cultural characteristics. In general, Caucasian culture, more specifically U.S. culture, may emphasize a more individualistic and capacity approach (Green et al., 2005; He, 2007; Hofstede & McCrae, 2004; Jenkins, 2006; Pena & Fiestas, 2009). A predominantly individualistic view supposes an emphasis on the ability and desire of the individual to figure things on their own,
pursuing their interests without much interference, and relying on ability to succeed. That may be why Caucasian students would mention ‘not understanding,’ which would reflect on their ability, more often as the factor least enjoyed about math. Comments such as “talent is way overrated” in America as opposed to the effort notion of “the more you do something, the more you are comfortable with it” (Oliver, 2011a) serve as an example of the negative perception on the perceived tendency in the U.S. to ascribe success to ability rather than to effort.

Latino cultures are considered to have, for the most part, a more collectivistic (Green et al., 2005; Pena & Fiestas, 2009; Schwartz, 2009) and effort approach. A collectivistic culture emphasizes the importance of the group over the individual, often calling for sacrificing one’s individual goals for the benefit of the group, permeating the formation of values and also career decisions. The collectivistic view would seem to emphasize sacrifice and effort over relying on ability. For Latinos, it is not surprising that math being ‘hard’ (i.e., requiring more effort), would be mentioned more often than ‘not understanding’ (which reflects on ability) as the least liked factor about math. However, generalizing too much about cultural differences may result in inaccurate conclusions. For example, Latinos are a very heterogeneous group with many differences among them (see Garcia & Bayer, 2005; Pascarella, 2006; Torres, 2004): A Latino student whose family has lived in the United States for many generations may have more cultural elements in common with a Caucasian-American than a recent Latino student whose parents emigrated from Argentina (Schwartz, 2009). There may be differences even in the same family from one generation to another (Pena & Fiestas, 2009). It is also important to take into account that individualism and collectivism should not be seen as opposing constructs (Green et al., 2005; Oyserman et al., 2002; Rodriguez & Olswang, 2003; Schwartz, 2007). Different ethnicities
as well as individuals can have individualistic as well as collectivistic values though they may gravitate more towards one type than another.

Socioeconomic status, a factor which this study lacks, can be useful in better understanding some of the apparent differences in elements that affect math values and perception of math achievement (Ferrante, 2012; He, 2007; National Science Board, 2012; Pena & Fiestas, 2009; Roberts & Bryant, 2011; Schwartz, 2009). Another factor that is vital in shaping students’ math values and perceived math achievement is their notion of success and the role teachers play in it.

*The Teacher’s Role in Students’ Notions of Success*

Not surprisingly, students ascribed their success in classes to being able to understand and finding the class interesting and/or easy. Facilitating understanding and engaging students in an interesting manner would seem to be obvious and perhaps often given advice, but when asked directly about their teachers’ role in their success, ‘teach,’ ‘help,’ and ‘give time’ were the most common answers given by low math rate students. Based on the results, especially for Latinos a teacher who ‘teaches right,’ ‘helps’ and is supportive and inspiring, can have a significant influence on their success in a class. Interestingly, of students who mentioned the teacher as the least enjoyable factor about math, 91% were Latino. The finding that Latino students were five times more likely to mention the teacher as the least enjoyable aspect of math than Caucasian students agree with findings of a study that showed a teacher bias toward white male students (Riegle-Crumb & Humphries, 2012). This study indicates that teachers play a vital role in students’ perception about success. Based on the results of this study, teachers’ potential to influence students’ math values and perception of math achievement may play even a more prominent role in Latinos.
A community approach: Caring, motivating, and challenging

Other actions students perceived teachers did that helped their success were ‘care,’ ‘motivate,’ and ‘challenge.’ Most students said their math teachers cared about their success in math and only a minority of students said their math teacher would let them fail. However, only half of students said their math teachers were highly motivating and challenging; low math rate students were eight times more likely to say that their math teachers did not tell them they were good at math than high math rate students. Of students who perceived being recognized as good in math by their teachers, the percentages of males were consistently higher than those of females in all academic stages.

There seems to be a need to connect the math/science that is taught in school and the math/science that occurs in real-life situations (Jenkins, 2006; Oliver, 2011b; Reiss, 2012; Sorensen, 2011). Moreover, less than half of high math students, and only one of five low math students said their teachers taught the way they liked to learn. Though some have stated that teachers are improving how they teach (e.g., Reiss, 2012), others still criticize the current educational system as one that purposefully “weed[s] out students who may actually have the skills to do well” (Emdin, 2011). Furthermore, “teachers with high capacity to teach their discipline” are needed (BSE, 2011, p. 2). But that is not enough; there is a need for effective instruction in supportive learning environments (BSE, 2011). There needs to be a teacher-student connection/bond and a sense of community. Teachers must nurture students rather than talk down to them. As a physics professor said, “the messenger is often more important than the message” (Young, 2012). Teachers must be sensitive to family and cultural values (Pena & Fiestas, 2009).
Further research must be conducted to better understand what factors students consider important for academic success. Investigating the reasons for success ascribed by high math rate students would also expand knowledge in this area. Moreover, research is needed to better understand what actions students perceive teachers take that contribute to their success in classes. It is telling that for students, the number one thing a teacher did that helped them be successful in a class was to ‘teach right.’ It is necessary to further investigate what to ‘teach right’ means for students; perhaps it means clarity in presenting the material (Reynolds & Walberg, 1992). Also, further studying how students’ perceptions on teachers’ willingness to help and provide them with time and encouragement affect their conception of success in courses would be informative.

**Gender and Race/Ethnicity Considerations to a STEM Recruitment and Retention Approach**

*By gender*

Should there be a gender-based and or a race/ethnicity-based approach to promote the STEM disciplines? Should different strategies be considered based on gender and/or race/ethnicity? What would be the implications of such measures?

The impact of math values on perceived math achievement may tend to be higher in males than in females. However, females may be more susceptible to the effect of negative math values on perceived math achievement than males (Gunderson, Ramirez, Levine, et al., 2012). Why would females’ perception of their math achievement be more susceptible to negative beliefs, feelings, and attitudes about math than males? Further research is necessary to determine if that is so, and if so what may be the reasons for it? This would in turn aide in the development of more successful strategies to mitigate and perhaps modify this apparent females’ higher susceptibility to negative math values (e.g., Gunderson, Ramirez, Levine, et al., 2012; Hannula, 2002).
By race/ethnicity

The impact of external math values (i.e., my perception of others’ feelings and beliefs about my math ability and interest) on internal math values (i.e., my feelings and beliefs about my math ability and interest), as well as the impact of math values (i.e., external, internal, negative) on perceived math achievement may be greater on Caucasian than on Latino students. Perhaps Caucasian students are, for some reason(s), more receptive and affected than Latino students when it comes to values about math.

Though Latinos seemed to be less impacted by negative math values, they seemed to be less receptive to positive math values. For Caucasians, though positive math values impact them at a higher degree than Latinos, they appeared to be more vulnerable to the impact of negative math values as well. What are the reasons for these apparent differences? And what would that mean with regards to achievement, recruitment and retention efforts to STEM. Based on the results of this study, the possibility that Latinos’ math values and perceived math achievement may be harder to influence, supposes a need to further investigate whether there are differences in their reception/openness to others’ influences, especially with regards to who those others may be (e.g., family, friends, acquaintances). Identifying other factors that play a role in the formation of Latino students’ math values and perceived math achievement would facilitate the development and implementation of strategies to positively influence Latino students more effectively.

Who and when: The frequency parents, teachers, peers, and self communicate an awareness of being good in math at the different academic stages through the lenses of gender and race/ethnicity
By gender

For males who became aware of being good at math in elementary school, the frequency with which the more intimate relationships (i.e., parents and self) made them aware of it was greater than the frequency with which the less intimate relationships (i.e., teachers and peers) did; for those who became aware later on it was the less intimate relationships who made them aware more frequently as shown in Figure 8, which shows the level of influence by others (i.e., parents, teachers, and peers) as well as self-awareness for male and female students in each academic level (i.e., elementary, middle, and high school) with regards to math ability.

Figure 8. Influence of Parents, Teachers, Peers, and Self on Math Ability Awareness at Different Academic Stages by Gender
The relationships at the top at each academic level are the more influential while the relationships at the bottom are less frequently influential with regards to math ability.

The intimate-less intimate relationships frame (see Figure 9) supposes that the self tends to be the most intimate relationship of an individual, followed in proximity by parents, and then by the less intimate relationships of peers and teachers. However, these circles of intimacy may exert different amounts of influence at different developmental stages of an individual and with regards to different issues of life. The intimate-less intimate relationship frame applied in the analysis of math ability to males (i.e., the more intimate relationships exerting more influence in elementary school and the less intimate relationships exerting more influence in middle and high school) was not applicable to females; a different pattern came up.

Figure 9. Intimate-Less Intimate Relations Framework

Note: This framework supposes that the Self is the most intimate relationship of an individual, followed in proximity by parents, and then by the less intimate relationships of peers and teachers. These circles of intimacy may exert different amounts of influence at different developmental stages of an individual and with regards to different issues of life. There may be circumstances and/or issues in which the less intimate relationships may wield a greater influence than the more intimate relationships.
A closer look revealed that the order of frequency different relationships made females aware of being good at math in elementary, from most to least frequent, was Parents-Teachers-Self-Peers while in middle school was the inverse, Peers-Self-Teachers-Parents (see Figure 8).

Not only that, but for those who became aware in high school, the pattern reversed to the one shown by those who became aware in elementary school.

*By race/ethnicity*

For Latinos who became aware of being good at math in elementary school, the frequency with which the more intimate relationships (i.e., parents and self) made them aware of it was greater than the frequency with which the less intimate relationships (i.e., peers and teachers) did; for those who became aware in middle school it was the less intimate relationships who made them aware more frequently (see Figure 10). However, the intimate-less intimate relationships frame did not apply to Latinos who became aware in high school, since the less intimate relationships (i.e., teachers and peers) took a second place to parents (see Figure 10).

For Caucasians who became aware of being good at math in elementary school and middle school, the pattern that came up was similar to the one observed in females; the order of frequency different relationships made Caucasians aware of being good at math in elementary school and middle school was similar to the one observed in females. For Caucasians who became aware of being good at math in high school, however, the pattern shifts to an intimate-less intimate relationships frame.
In sum, these observations seem to suggest that students may be influenced by parents, self, teachers, and peers at different frequencies at different academic stages. Different strategies and emphases may be used at different academic stages, but that these strategies may not be as simple as a gender-based and/or race/ethnicity-based approach; modes of learning and personality and other human development considerations may need to be taken into account (Gunderson, Ramirez, Levine, et al., 2012; He, 2007).

Career Considerations: External Influences and Expectations

It is significant that approximately half of the students surveyed said there was not a person who had significantly impacted their career choice. In addition, that only a minority of students said that their parents and teachers were influencing them to a math/science career is telling given the fact that family was the most likely meaningful influence for students when it
comes to career choice, regardless of gender, and for both Latino and Caucasian students. “STEM majors almost always have at least one scientist in the family, usually a parent,” who serves as an example of “STEM-minded careers” (Emdin, 2011). Parents with limited expectations and knowledge regarding different careers may prove crucial to their children’s career choices.

Teachers were the second most likely significant influence on career choice. For this reason, establishing strategies to better inform parents about career possibilities and requirements for their children, from early on, should result in better informed students (BSE, 2011, p. 3). Such a strategy, along with efforts to promote positive math values and encourage a healthy expectation of math achievement, may contribute to expand the career options available to students. Teachers are also crucial in these efforts. Based on the results of this study, teachers should be mindful and take advantage of the fact that students, especially Latinos and females, may see them as a significant influence when it comes to career choice.

As individuals grow and advance in their academic development, it seems that parents’ influence diminishes while peers’ influence increase, especially in adolescence when individuals are looking for independence from their parents and at the same time acceptance from their peers. Peers’ influence becomes more central and may have a greater effect on students’ choices and academic achievement than parents and teachers from middle school on (Gallagher, 1996; Kinney, 1993; Pierce, 2005; Smyth & Hattam, 2004 in Creasy Fowler, 2010; Stake & Nickens, 2005). When it comes to career choice, however, it appears that adolescents expect and or desire input from external sources, especially from parents (Grotevant, 1988; Hartley, 2011; Palmer & Cochran 1988; Young, 1994). The results of this study indicated that peers did not seem to be a likely significant influence on students’ career choice. This finding agrees with previous research.
that indicates that parents are often the most significant influence in students’ career choice (Adamuti-Trache & Andres, 2008; Bleeker & Jacobs, 2004; Bregman & Killen, 1999; Blustein, 1988, 1989; Blustein et al., 1991; Ketterson & Blustein, 1997; Kracke, 1997; Meece et al., 2006; Middleton & Loughead, 1993; Palmer & Cochran, 1988; Stage & Maple, 1996). High school female students tend to identify their parents as the most important influence with regards to career choice, followed by friends, and teachers being the third most influential (Henman, 2010; see also Leewie & DiPetre, 2011).

Of students who did mention their friends as a significant influence, Caucasians were six times more likely than Latinos to say their friends had a significant impact on their career choice. Perhaps Caucasian parents tend to encourage their children to be more independent and are less likely to interfere with their choices and preferences than Latino parents who may encourage a closer more collectivistic view and expect their children to be more mindful of their family members’ opinions (He, 2007). It may be that Caucasian students whose parents are less involved in their career considerations may turn to their friends as a source of information, making friends a more significant influence than for non-Caucasians. Other people (i.e., singers, actors, authors, and professional sports players) had a greater impact on males’ and Latinos’ career choice than friends. Only a minority of students said that a math/science career was held in high esteem by society; and only a minority said they had strong role models in math/science. More math/science role models and in a variety of professions are needed (Edmin, 2011; Reiss, 2012).

Possible Strategies to Impact Students’ Career Choice

Based on the results of this study, the following are specific characteristics and actions that can have a great likelihood of making a significant impact on a student’s career choice.
Though these are mostly applicable to students regardless of gender and/or race/ethnicity, I have divided them by these categories in order to highlight the notion that different strategies may be considered on the basis of reception when targeting particular students:

<table>
<thead>
<tr>
<th>The two most common actions:</th>
<th>Encourage</th>
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<tbody>
<tr>
<td></td>
<td>Show that the career is one that can be enjoyable</td>
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<tr>
<td>For males:</td>
<td></td>
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<tr>
<td></td>
<td>Care</td>
</tr>
<tr>
<td></td>
<td>Explain the options and possibilities a career offers</td>
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<td></td>
<td>Being the first in the family to graduate from high school/college</td>
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<tr>
<td>For females:</td>
<td></td>
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<tr>
<td></td>
<td>Make them aware of the potential a career has to help others</td>
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<tr>
<td></td>
<td>Make them aware of the benefits of a career (e.g., working conditions, independence, recognition, respectability)</td>
</tr>
<tr>
<td></td>
<td>Personal qualities (e.g., work ethic, leadership, honesty, perseverance, passion, confidence, responsibility, independence)</td>
</tr>
<tr>
<td>For Latinos:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Being the first in the family to graduate from high school or college (May not be effective with Caucasian students)</td>
</tr>
<tr>
<td></td>
<td>Communicate the benefits and possibilities of a career (e.g., financial, working conditions, independence, recognition, respectability)</td>
</tr>
<tr>
<td></td>
<td>Care</td>
</tr>
<tr>
<td></td>
<td>Help</td>
</tr>
<tr>
<td></td>
<td>Give them access to experience the career</td>
</tr>
<tr>
<td></td>
<td>Make them aware of the potential a career has to help others</td>
</tr>
<tr>
<td>For Caucasians:</td>
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<tr>
<td></td>
<td>Support their career choice</td>
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<tr>
<td></td>
<td>Make them aware of other people’s hardships</td>
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<tr>
<td></td>
<td>Challenge them to prove you wrong</td>
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</tbody>
</table>

*Most enjoyable aspects of a math/science career*

Though there was a lot of variety among the aspects students like about math/science career, there were no significant differences between Caucasians and Latinos. Similarly, there were no differences by gender with respect to the most mentioned aspects they enjoyed most about a math/science career (i.e., the math/science itself, learning/discovering, solving problems, and the challenge the chosen career presented). However, when less mentioned factors were considered, some hints of gender differences emerged. For example, though a substantially small
percentage said that working with people and benefiting people/society was what they most enjoyed about math/science careers, it is telling that the great majority were female. It is also of interest that males were the great majority of those who said that what they enjoyed most about a math/science career was that they were good at it, or that it was easy for them. Though very few mentioned pay as the top reason for enjoying a math/science career, the great majority of those who did mention it was male.

Altruistic Career Considerations

An evaluation of students’ altruistic career considerations yielded the interesting results that more low-math rate students wanted a career in an area that directly helped people than high-math rate students. Especially after considering that statistical analyses had showed no significant relationship between perceived math achievement and altruistic considerations. Why the difference between high and low math rate students with regards to the altruistic value of pursuing a career that directly helps people?

If low-math rate students are more likely to be interested in a career that directly helps people, their perception regarding the altruistic qualities of a math career compared to a non-math career may be a significant factor that may impact their career choice. But students’ altruistic career values very slightly, if at all, seemed to influence their perceptions of a math career as less altruistic than a non-math career; only among males and Latinos did altruistic career values slightly show a positive relationship with the notion that a math career was less altruistic than a non-math career. On average, only one of ten students saw a math career as helping people more directly than a non-math career. In conclusion, even students who may want a career that directly helps people, may not necessarily see a math career as a vehicle that allows them to do so.
In addition, it appears that very few students tend to be interested in a career that impacts social issues; and even those who may be interested in such a career may see other careers than math as having a greater social impact. What is more, half of the students had no opinion on whether a non-math career had more impact on social issues than a math career and only 12% saw math careers as having a greater social impact than non-math careers.

Only for Caucasians was the relationship between math values and math-as-a-less-altruistic-career a significant one. Even if Caucasians’ altruistic career values did not have a significant impact on the notion of math-as-a-less-altruistic career, that Caucasians with favorable math values may not perceive a math career as less altruistic than a non-math career may facilitate choosing a math career. This possibility seems to concur with additional results that showed that the higher an individual’s negative math values in particular, the more likely that individual will perceive that a math career is less altruistic than a non-math career, especially for Latinos. Whereas Latinos may be more prone to resist seeing a math career as more altruistic than a non-math career, Caucasians may be less likely to see a conflict between math values and the notion of a math career as less altruistic than a non-math career.

*High Math Expectations, Low Expectations, or Appropriate Expectations?*

Should all parents expect their children to excel in science, technology, engineering, and math to become mathematicians and engineers? The debate of whether the expectations for today’s students are too low or that overemphasis on fostering students’ individual interests and capacities overshadows that of instilling an ethic of work and effort as well as students’ altruistic values is in the arena of general public opinion. An unhealthy stress on solely individualistic interests and natural capacities is just as damaging as would be the illogical assumption that every student should pursue a career in STEM.
Not everyone can or should aspire to become a mathematician or an engineer, but the reality is that there is an increasing need for people with those skill sets, and that fewer students seem to be interested in pursuing STEM fields careers. Perhaps even more fundamental, many jobs require some of the skills that are developed in these fields, even if those careers are not recognized as STEM. Furthermore, an adequate grasp of STEM-related skills can have a positive influence in success in non-STEM careers just as other skills enhance STEM disciplines. Ultimately, positive experiences and successful involvement in STEM (Emdin, 2011; Ferrante, 2012) can positively contribute to an individual’s personal overall sense of worth, realization, and satisfaction.

Limitations and Future Directions

I mention some of the limitations of this study and some recommendations for future directions in this section. Firstly, caution is always needed when generalizing from a sample to the general population. Because this study surveyed only rural high school students in the state of Washington, people must be careful when extrapolating findings from this study to other regions of the United States and to other populations. In addition, the number of African Americans, Native Americans, and Asian/Pacific Islanders were very limited, therefore making it impractical to make any statistical analyses and conclusions with regards to these ethnic groups in particular. Also, analyses were not conducted to examine the variables under study by grade level. Another factor to keep in mind is that the survey’s scores were delimited to the ability and desire of students to respond accurately and honestly to the questions. Students’ perceived math ability does not necessarily reflect their actual math ability accurately.

For future studies, and when samples permit it, an effort should be made to account for differences between different Latino groups. Latinos of Mexican descent comprise around 60%
of U.S. Latinos (Torres, 2004). The other groups that follow in rank order are: Puerto Ricans (10%), Cubans (4%), Dominicans (2%), Salvadorans (2%), Colombians (1%), Guatemalans (1%), Ecuadorians (1%) and Peruvians (1%). Mexicans/Mexican-Americans tend to be concentrated mostly in the southern and western regions of the United States, while Puerto Ricans tend to be concentrated in the northeast and Cubans in the southern part of Florida. Mexican-Americans tend to be the focus of the research due to their population size and common elements shared by the different Hispanic/Latino groups: common language, common group identity, sense of community, and vision of family values. However, there are substantial differences between Latino groups. Educational and social sciences research and the media often analyze this group as a whole, which can substantially misrepresent the relationship between different Latino groups not only in terms of educational attainment (Garcia & Bayer, 2005) but in politics, business, and others aspects of society. The experiences of different Latino groups with regard to educational achievement, economic attainment, immigration, and their implications are very diverse.

Migration

For example, Torres (2004) gave a brief description of the characteristics and historical background of the different migration types of each Latino group. Torres referred to Puerto Ricans as a commuter nation by pointing out the political relationship between the United States and Puerto Rico (and U.S. citizenship of Puerto Ricans) which explains the comparatively easier and more fluid ability and freedom of movement. She argued that the main motivation for Puerto Ricans to migrate to the mainland has been economic reasons. Puerto Ricans are the second largest group of U.S. Latinos (10%), not including those who remain in Puerto Rico, a U.S. territory (Torres, 2004).
The Cuban migration has had three waves, each one different from the other. The first wave is said to have consisted mainly of educated and wealthy Cubans who were escaping the Cuban revolution of 1959 (Torres, 2004). The second wave was intended to reunite those families that had been separated as a result of the first wave. According to Torres, the second wave brought more skilled workers and fewer professionals. Although the third wave was considered to be one of undesirables, Torres argued that “this wave of exiles was similar in educational and occupational backgrounds” to the two previous waves. Since Cubans have been given political exiles status, Torres pointed that such a privileged situation, in which it is easier to immigrate to the U.S. for Cubans than for other Latino groups, has caused tensions between them.

Dominicans have also migrated for economic reasons, but their migration has also been influenced by politics. For Central and South Americans, Torres (2004) declared different migration patterns. Although many of them are mainly for economic reasons, wars in some of those countries have also propelled migrations.

Economic attainment

According to Torres (2004), Cuban-Americans have the largest percentage (34%) of workers earning $35,000 or more. However, even Cubans are significantly behind Caucasians in terms of economic attainment. As another indicator in this category, Torres presented the percentage of people living below the poverty level, for which Puerto Ricans have the largest percentage (23%).

Educational attainment

Among U.S. Latinos, Cubans are most likely to have at least a high school education (73%) and Mexicans are the least likely (51%). There is still a large gap between Latinos and
non-Latinos with respect to educational attainment (Gregory, 2003; Guyll et al., 2011; Lane, 2001; Nora, 2004; Torres, 2004). This, in turn, affects the ability of Latinos to obtain a higher education and fill jobs in general, and STEM jobs in particular. As an example, Torres reported that Cubans (42%) and Puerto Ricans (29%) have the highest percentage of high school graduates enrolled in undergraduate higher education.

Mexicans remain significantly less likely than others to attain a college education. These differences hold even after controlling for other background factors which influence the level of educational attainment. Research which employs an aggregate Latino group may yield results which are statistically less significant in predicting outcomes because some subgroups with lower attainment are counterbalanced by some subgroups in the aggregate with average, or even possibly higher than average educational attainment. Torres (2004) indicated that immigrants from South America are most likely to complete college in comparison with other Latino groups.

Number of generations living in the U.S.

First generation students are believed to be less likely to enroll in college. Also, Torres (2004) pointed out that older students tend to enroll in two-year institutions, while more traditional-age students tend to enroll in four-year institutions and tend to do so in a full-time basis. It has been difficult to determine if some differences are due to Latino sub-group membership or due to other factors such as gender, length of time residing in the U.S., acculturation, academic performance, parental education and occupation, generational effects, family structure/mother-only household, father’s and mother’s nativity, types of schools attended, school program, geography-related elements (see also Guyll et al., 2010).

There is a need for a continuous evaluation and understanding of changes in circumstances and social structures. Even though there are common issues that make Latinos as a
whole to lag behind non-Latino Caucasians in educational attainment, it is important to understand both what is shared as well as the differences. Furthermore, in order to understand the different groups that constitute Latinos there is a need to: 1) develop more accurate models (theoretical/methodological); 2) have greater cultural sensibility; 3) highlight new possibilities that can contribute in addressing some of these issues; 4) expand our notion of diversity and acknowledge the increasing heterogeneity of the U.S. population (Pascarella, 2006). The same experiences might not have the same impact for all Latinos, but rather might differ in the magnitude or even the direction of its impact for Latinos with different characteristics or traits (Pascarella, 2006). If we are to responsibly and honestly address issues that affect Latinos, it is imperative to extend and expand our vision and not ignore these groups, taking into account shared elements as well as differences.

*Socioeconomic status*

An element of crucial importance that may play even a bigger role than gender and/or race/ethnicity may be socioeconomic status (see Smith & Hausafus, 1998; Zellman & Waterman, 1998). Socioeconomic status has been found useful in understanding some of the differences on students’ math values and perceived math achievement (Ferrante, 2012; He, 2007; National Science Board, 2012; Pena & Fiestas, 2009; Schwartz, 2009). Racial/ethnic minorities may feel uncomfortable in classrooms where they may be perceived as less of poor economic means (Brickhouse & Potter, 2001) and may decide to drop out (Smyth & Hattam, 2004 in Creasy Fowler, 2010). Thus, Future studies examining math values, perceived math achievement, and career considerations should include measurements of socioeconomic status to obtain a more accurate picture of the different factors that may play a role concerning STEM recruitment and
retention. Simpkins et al., (2012) advised that future studies should include and assess populations from different ethnic backgrounds and socioeconomic status.

**Geographical area**

Another aspect to consider in future research is geographical location of the participants. For example, students that reside in rural areas may decide not to pursue a STEM career as traditional values may not emphasize a college degree (e.g., Jacobs et al., 1998). Familial ties and expectations to stay close to home may also limit rural students’ educational and career options as STEM careers sometimes mean moving far away from family and friends (Broomhall & Johnson, 1994). Creasy Fowler (2010) stated that there is limited research on rural females’ STEM career choice.

**Middle School Transition**

An increasingly important factor that should be further studied is school transitions, especially from elementary school to middle school. The transition from elementary to middle school has been linked to academic interest deterioration (Dotterer et al., 2009). Studies that have examined K-6 and K-8 school organizational plans have had mixed results as to whether one is better than the other with regards to students’ academic achievement (see Williams et al., 2010; West & Schwerdt, 2012).

**Further Improvement of Constructs’ Measurement**

In addition, further improvement of measurement of the constructs examined in this study (i.e., external, internal, negative math values; altruistic career values, and the perception of math as a less altruistic career) is desired. Also, designing questions to better examine students who tended to stay neutral to many of the questions is also of importance. Another consideration for future directions is the further development of the assessment of the role grade levels and the
dropout factor play in the formation/modification of math values, perceived math achievement, and STEM career choice.

**A Better Approach: Considerations to Cultivate More Positive Math Values, Improve Math Achievement, the Recruitment and Retention of Students**

The results of this study are in accordance with several elements that must be taken into account when addressing issues of underrepresented groups as they relate to achievement and success in STEM. The needed resources to employ strategies that encourage students’ awareness of ‘the human element,’ the social aspects of math, and that allow for the development of positive math attitudes must be provided (Jenkins, 2006; Lafortune et al., 1999; Oliver, 2011b; Reiss, 2012; Sorensen, 2011). Teachers should: 1) pay attention to all students; 2) have high expectations for all students; 3) avoid stereotypes; 4) challenge gender and racist prejudices; 5) make the math relevant; and 6) present math as a process rather than a set of rules (Solar, 1995). It is important to encourage students to be active participants in their own learning by utilizing non-traditional approaches that result in positive math values and better math achievement (Lafortune et al., 1999; Rickel, 2005). For example, incremental theories, which promote the malleability of intelligence, tend to instill in students the belief that working hard can result in improvement and can motivate them to persist when facing difficulties that can result in learning (Gunderson, Ramirez, Levine, & Beilock, 2012, p. 158; Jenkins, 2006). A life narrative subjective approach, for example, which provides students with the opportunity to intertwine what is being learned to their lives’ stories, result in more meaningful and lasting learning (Rickel, 2005, pp. 24-25). Further research must be conducted to better understand what factors students consider important for academic success. For example, it is important to examine why
females may be more susceptible to the effect of negative math values on perceived math achievement than males.

Conclusions

Overall, this study has examined high school students’ values about math, perceived math achievement, and STEM career choice. Math values play a significant role in students’ perceived math achievement. Students may be forming their perceptions about math already in the earlier stages of their academic experience. Positive math experiences early on may favorably affect an individual’s values about math. Transitions, especially from elementary school to middle school, may have negative consequences on students. Some salient factors that may contribute to the difficulty of these transitions may be: 1) natural developmental changes in individuals, 2) less than optimal learning environments (i.e., unwelcoming, less supportive, lack of resources), and 3) teachers who cannot effectively engage students. These negative effects may be more pronounced for females and racial/ethnic minorities. According to results of this study, females may be at a greater disadvantage since their values about math may be less favorable from an earlier stage than males, possibly internalizing an aversion for math that may be more difficult to address once they have reached the later stages of their academic careers. Students may be influenced by parents, self, teachers, and peers at different degrees at different academic stages. Different strategies and emphases may be used at different academic stages. These strategies, however, may not be as simple as a gender-based and/or race/ethnicity-based approach; modes of learning and personality and other human development considerations need to be considered.

Values about math also influence a person’s altruistic career values in general, thus playing a role in STEM career choices. Even students who may have high altruistic career values may not necessarily see a math career as the channel that allows them to fulfill those interests.
Efforts to promote positive math values and encourage a healthy expectation of math achievement, may contribute to expand the career options available to students. More STEM role models with a wider-ranging array of careers are needed (e.g., Edmin, 2011; Creasy Fowler, 2010; Reiss, 2012). Although it is impractical to expect all students to pursue STEM careers, positive experiences and successful involvement in STEM can certainly add to students’ personal overall sense of value, success, and fulfillment (Adamuti-Trache & Andres, 2008).
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Education. Stylus, Sterling.


MEMORANDUM

TO: Denny Davis, Jennifer Beller, Gerald Maring and Sandra Cooper  
College of Education, Pullman (2136)

FROM: Malathi Jandhyala (for) Kris Miller, Chair, WSU Institutional Review Board (3140)

DATE: 9 February 2007

SUBJECT: Approved Human Subjects Protocol - New Protocol

Your Human Subjects Review Summary Form and additional information provided for the proposal titled "Culturally- Relevant Engineering Applications in Mathematics," IRB File Number 9572-a was reviewed for the protection of the subjects participating in the study. Based on the information received from you, the WSU-IRB approved your human subjects protocol on 9 February 2007.

IRB approval indicates that the study protocol as presented in the Human Subjects Form by the investigator, is designed to adequately protect the subjects participating in the study. This approval does not relieve the investigator from the responsibility of providing continuing attention to ethical considerations involved in the utilization of human subjects participating in the study.

This approval expires on 8 February 2008. If any significant changes are made to the study protocol you must notify the IRB before implementation. Request for modification forms are available online at http://www.ogrd.wsu.edu/Forms.asp.

In accordance with federal regulations, this approval letter and a copy of the approved protocol must be kept with any copies of signed consent forms by the principal investigator for THREE years after completion of the project.

Washington State University is covered under Human Subjects Assurance Number FWA00002946 which is on file with the Office for Human Research Protections.

If you have questions, please contact the Institutional Review Board at (509) 335-9661. Any revised materials can be mailed to the Office of Research Assurances (Campus Zip 3140), faxed to (509) 335-1676, or in some cases by electronic mail to irb@wsu.edu.

Review Type: NEW  OGRD No.: NF
Review Category: EXP  Agency: NA
Date Received: 5 February 2007
APPENDIX B

WASHINGTON STATE UNIVERSITY

Washington State University Institutional Review Board (IRB)
Office of Research Assurances
PO Box 643005 Albrook 205
Pullman, WA 99164-3005

Telephone: (509)335-3668  Fax: (509)335-6410  Email: irb@wsu.edu  Web site: www.irb.wsu.edu

Continuing Review

Principal Investigator: Jennifer Beller, Co-PI  IRB No.: 9572-002
Project Title: Culturally Relevant Engineering Applications in Math

Check current status below and follow the directions for that option.

☐ Data collection for this research was completed according to the original application approved by the IRB. I DO NOT wish to renew IRB Approval for this study. Complete Section A, sign and return this form.

☒ Data collection for this research is still active and being conducted according to the original application. I DO wish to renew IRB Approval for this study. Complete Sections A and B, sign and return this form.

☐ This research was never initiated, and I DO NOT wish to renew IRB Approval of this study. Sign and return this form.

☐ This research was never initiated, but I would like to renew the application. Complete Section C, sign and return this form.

IMPORTANT

If the research has been revised since its most recent approval, or you intend to revise the research, submit a Request for Amendment Form to the IRB. This form is located at www.irb.wsu.edu/forms.asp

SECTION A

1. Describe any adverse events related to subject participation and describe how you handled each adverse event.
   No adverse events were experienced as all activities consisted of projects similar to those completed in the course of normal school activities.

2. Were any of these events unexpected or more serious than expected?
   ☒ Yes
   ☐ No

3. Describe any additional risks or benefits observed during the course of the study.
   None.

Version: February 2008

Page 1 of 2
SECTION B

1. Activity Status
   ☒ New subject enrollment still in progress
   [ ] Enrollment closed, but subjects are still undergoing study procedures
   [ ] Enrollment closed, subjects have completed study procedures, but are still in follow-up

2. Participant Numbers
   803# of participants enrolled since original approval
   312# of participants actively enrolled (at present)
   200# of additional participants needed to complete the study

3. Provide a summary of your progress to date.
   For the five semesters, Graduate Engineering fellows have been placed in various middle or high schools around Eastern Washington to assist with the development and delivery of culturally-relevant applications of engineering to math. Anxiety and attitude surveys were collected for all participants. Additionally, for the last two years, a pre-and post-measure of problem-solving ability were collected prior to and subsequent to the graduate fellows involvement in the curricula. NSF has granted us a one year no-cost extension to continue the project. The final year, the project will fund 4 fellows and place them into two schools and will follow the procedures approved in the grant and by IRB.

4. When do you expect the research to be completed?
4. When do you expect the research to be completed?
   June, 2010

5. Attach a copy of current consent form(s).

SECTION C

1. Provide an explanation of why the research was never initiated.

2. When do you expect the research to be completed?

3. Attach a copy of current consent form(s).

Signature of P.I.: ___________________________ Date: 1-23-09

RETURN THIS FORM TO OFFICE OF RESEARCH ASSURANCES (ORA) Campus Zip 3305

IRB USE ONLY:
Level of review: [ ] Expedited [ ] Full Board
Level of review: [ ] Expedited [ ] Full Board

IRB Signature: _______________ Date: _______________
APPENDIX C

“To Do or Not to Do:” Science, Technology, Engineering, Mathematics

Gender

[ ] Male  [ ] Female

Race

[ ] Caucasian  [ ] African American  [ ] Hispanic/Latino
[ ] Native American  [ ] Asian/Pacific Island

Other ____________________________

[ ] Freshman  [ ] Sophomore  [ ] Junior  [ ] Senior

Current Math Course ____________________________________________

Current Science Course __________________________________________

[ ] Athlete  [ ] Sport ____________________________  [ ] Non-athlete

Please rate your overall mathematics performance on a scale of 1-5, 1 = extremely low level, to 5 an extremely high level:  1  2  3  4  5

Extremely Low  Extremely High

If you perceive yourself as a 4 or above, please answer the following questions (otherwise skip to Section B):

At what age did you realize that you were good at math? ______
At what age did your peers recognize that you were good in math? ______
At what age did your teachers recognize and tell you that you were good in math______
At what age did your parents recognize and tell you that you were good in math______

Section B: If you perceive yourself as a 3 or below in math:

At what age did you realize that math was difficult for you? ______
Did your peers say you were not good in math? ______
Did your teachers say you were not good in math?______
Did your parents say you were not good in math?______
If you perceive yourself as a 3 or lower, what courses are you successful in?

Why do you think you are successful in these courses?

If there was a teacher who influenced how successful you were in these courses what is it that they did that helped you be successful?

Please mark the appropriate response at the right. There are no right or wrong answers. Please take your time 😊

1. I am good at math.  
2. My peers say I was good at math.  
3. My math teacher(s) say I am good at math.  
4. My science teacher says I am good at math.  
5. My math teacher won’t let me fail.  
6. I want a career in laboratory settings.  
7. I want a career in an area that directly helps people.  
8. I want a career that directly impacts the sustainability of our planet.  
9. I want a career that directly impacts societal issues.  
10. A career in math is in high demand.  
11. A career in science allows me to team with highly motivated people.  
12. I like the challenge of math.  
13. I like the challenge of science.  
14. My math teacher(s) is highly motivating.  
15. My math teacher(s) is highly challenging.  
16. My parents are influencing me to a career in science/math.  
17. My teachers are influencing me to a career in science/math.  
18. My math teacher cares about my success in math.  
19. A career in science/math is held in high esteem by society.  
20. I have strong role models in science/math.  
21. Math comes easy to me.  
22. Math teachers teach the way I like to learn.  
23. I am not as good in math as my peers.
24. My teachers/professors take little interest in my success in math.  
25. My peers have chosen other careers that seem more interesting and challenging.  
26. I see other careers than math as having more impact on societal issues.  
27. I see other careers as benefiting people more directly.  
28. A career in math has little impact on societal issues and problems.  

If you are choosing a career in science or math, what do you enjoy most about it?

What do you enjoy least about math?

If there is a person who has significantly impacted your career choice, what is it that they did that had such a strong influence on you?