Enhancing the Math and Science Experiences of Latinas and Latinos: A Study of the Joaquín Bustoz Math-Science Honors Program

by

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ABSTRACT

Latinas and Latinos are currently underrepresented in terms of our 21st century student academic attainment and workforce, compared to the total U.S. Hispanic population. In a field such as mathematical sciences, Hispanic or Latino U.S. citizenship doctoral recipients only accounted for 3.04% in 2009-2010. While there are various initiatives to engage underrepresented STEM populations through education, there is a need to give a voice to the experiences of Latinas and Latinos engaged in such programs.

This study explored the experiences of seven Arizona State University undergraduate Latina and Latino Joaquín Bustoz Math-Science Honors Program (JBMSHP) participants as well as examined how the program enhanced their math and science learning experiences. Participants attended either a five-week or eight-week program and ranged in attendance from 2006 to 2011. Students were provided an opportunity to begin university mathematics and science studies before graduating high school. Through a demographic survey and one-on-one guided interview, participants shared their personal journey, their experience in the JBMSHP, and their goals.

Using grounded theory, a qualitative research approach, this study focuses on the unique experiences of Latina and Latino participants. Four major themes emerged from the analysis of the data. Each participant applied to the program with a foundation in which they sought to challenge themselves academically through mathematics and/or science. Through their involvement it the JBMSHP,

participants recognized benefits during and after the program. All participants recognized the value of these benefits and their participation and praised the program.

Overall, the JBMSHP provided the students the resources to grow their academic capital and if they chose seek a STEM related bachelor degree. The results of this study emphasize the need to expand the JBMSHP both within Arizona and nationally. In addition, there is a need to explore the other components of their parent center, the Mathematical, Computational and Modeling Sciences Center (MCMSC), to determine if the suggested pipeline, MCMSC Model for Enhancing the Math and Science Experiences of Latinas and Latinos, can positively impact our 21st century workforce and the dire representational need of Latinas and Latinos in STEM fields.

DEDICATION

Me gustaría dedicarles mis estudios a mis padres Bertha y Gabriel Escontrías. A mis hermanos Rita y Alonso, y a mis sobrinos Sebastián, Cesar, y Scott por todo el amor y apoyo que siempre me han brindado. Gracias a Jesus Cristo que me ha dado la fuerza para seguir adelante, y llegar a esta meta, ya que con El todo es posible.

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I would like to thank my Brothers from Tau Psi Omega Fraternity, Inc. for giving me a home away from home at ASU since fall 1999. Deep gratitude to

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Chapter 1

Introduction

The Mathematical, Computational and Modeling Sciences Center (MCMSC) at Arizona State University (ASU) is home to two Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring programs: 1) the Strengthening the Understanding of Mathematics and Science (SUMS) Institute, which houses the Joaquín Bustoz Math-Science Honors Program (JBMSHP) and 2) the Mathematical and Theoretical Biology Institute (MTBI). The SUMS Institute was recognized in 2003 and represented by Dr. Joaquín Bustoz Jr., founder of both the MSHP in 1985 and the SUMS Institute a decade later in 1995 (Mathematical, Computational and Modeling Sciences Center, 2012). Recently, on December 14, 2011, Regents' Professor Carlos Castillo-Chávez, Executive Director of the MCMSC, represented the MTBI as President Barack H. Obama honored nine individuals and eight organizations with this prestigious award. President Obama said when he first announced the awardees, "Our nation owes them a debt of gratitude for helping ensure that America remains the global leader in science and engineering for years to come" and that "through their commitment to education and innovation, these individuals and organizations are playing a crucial role in the development of our 21st century workforce" (National Science Foundation, 2011).

Background and Need for the Study

In the most recent special report from Lumina Foundation, *A Stronger Nation Through Higher Education: How and why Americans must achieve a Big Goal for college attainment*, Jamie P. Merisotis, President and CEO of the Lumina Foundation, wrote a few comments on the affairs of higher education. For instance he believes that American higher education "is facing what might be called a 'Kodak moment' – and that's not a good thing." His point being that Kodak "suddenly found itself irrelevant" as we entered a new age of photography, the age of digital photography. In addition, he clarifies that "American colleges and universities are by no means irrelevant today," but does call on them to be more responsive to the needs of students as the "21st century student population is dizzyingly diverse – racially, ethnically, socially, economically, and in terms of age and family situation." In short, he feels that the "higher-ed must be retooled and redesigned to meet the needs of *all types* of students because we need these 21st century students to succeed – without delay and in far greater numbers" (2012). Mr. Merisotis echoes the sentiments of President Obama in that we have to focus on the 21st century…students and workforce.

A section of our 21st century that is currently underrepresented in terms of student academic attainment and workforce is our U.S. Hispanic population. According to the Pew Research Center (2008), the Hispanic population, 42 million in 2005, will rise to 128 million in 2050, tripling in size. Latinos will be 29% of the population, compared with 14% in 2005. Latinos will account for 60%

of the nation's population growth from 2005 to 2050. However, as stated we find the Hispanic student academic attainment to be the lowest nationally by population group as shown in Figure 1, and the second lowest in Arizona by population group when tracking degree-attainment (two-year degree or higher).

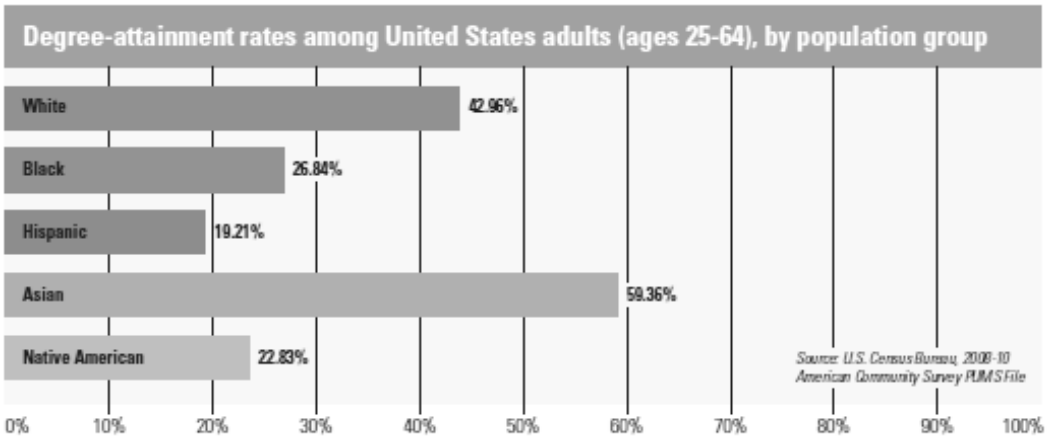


Figure 1. Degree-attainment rates among United States adults (ages 25-64), by population group

Specific to this study and the 21st century workforce data has been collected on New Hispanic or Latino Mathematical Sciences Doctoral Recipients of U.S. Citizenship as reported through the *Annual Survey of the Mathematical Sciences*. Over the last decade documented numbers of these recipients fluctuated and appear to show great progress as they have more than doubled to 24. However when compared to the total new mathematical sciences doctoral recipients of U.S. citizenship for 2009-10, new Hispanic or Latino recipients only account for 3.04%. Figure 2 documents the new Hispanic or Latino mathematical sciences doctoral recipients of U.S. Citizenship from 2000-01 to 2009-10.

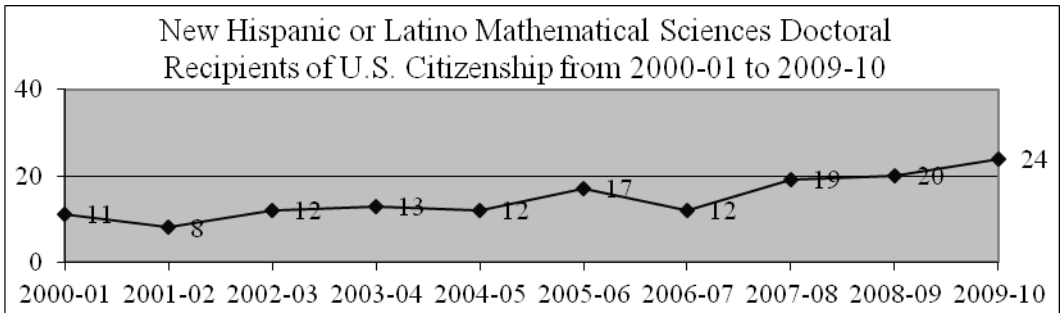


Figure 2. New Hispanic or Latino Mathematical Sciences Doctoral Recipients of U.S. Citizenship from 2000-01 to 2009-10

The increasing of the Hispanic or Latino population both nationally and in the State of Arizona calls for the need to explore the experiences of ASU undergraduate Latina and Latino JBMSHP participants as, well as to examine how the program enhanced their math and science learning experiences. The JBMSHP serves the State of Arizona and according to the Pew Research Center's "Latinos by Geography," as of 2010 Arizona has the 5th largest Hispanic county (Maricopa County) totaling 1,128,741 as displayed by Figure 3.

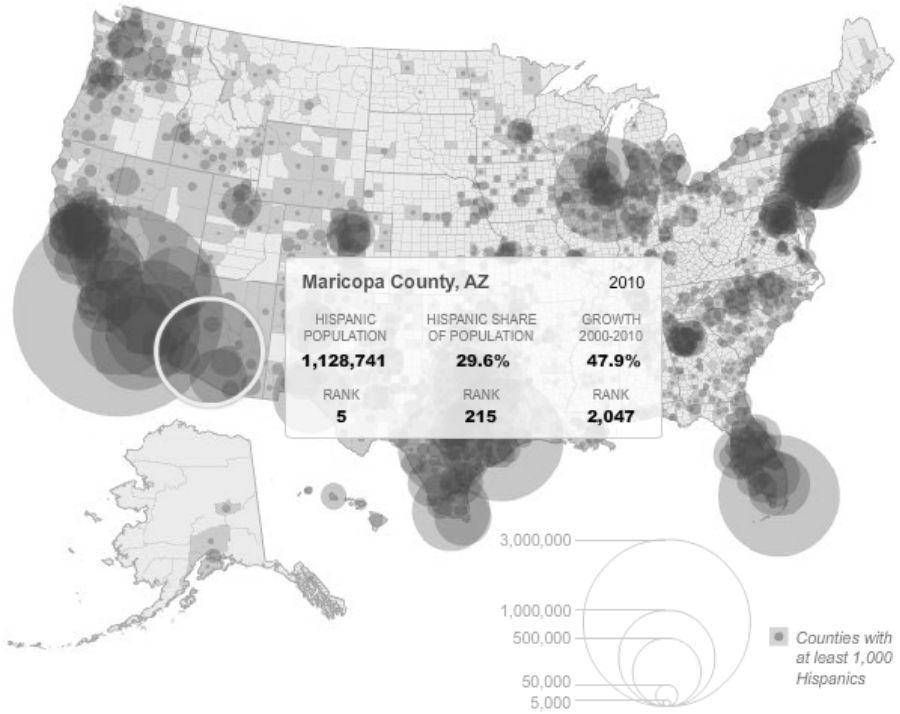


Figure 3. 2010 U.S. Hispanic Population by County

This study will help explore their experiences, but also tell through their individual accounts how a Center recipient of two Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring offers "their expertise and encouragement" as they "prepare the next generation of scientists and engineers while ensuring that tomorrow's innovators reflect and benefit from the diverse talent of the United States" (National Science Foundation, 2011).

Purpose of the Study

The purpose of this study was to explore the experiences of ASU undergraduate Latina and Latino JBMSHP participants as well as to examine how the program enhanced their math and science learning experiences.

Research Questions

The study was specifically designed to answer the following guiding research questions:

1. What factors do the participants perceive as contributing to their initial interest in the mathematical sciences?
2. What factors related to the JBMSHP do the participants perceive as influencing their continued interest in pursuing the mathematical sciences as a course of study?

Research Methods

The purpose of this study was to explore the experiences of ASU undergraduate Latina and Latino JBMSHP participants and therefore a qualitative research approach was selected for "exploring and understanding the meaning individuals or groups ascribe to a social or human problem (Creswell, 2009, p. 4). Grounded theory was selected as the method for this study to,

> Derive a general, abstract theory of a process, action or interaction grounded in the views of participants. This process involves using multiple stages of data collection and the refinement and interrelationship of categories of information (Charmaz, 2006, Strauss and Corbin, 1990, 1998). Two primary characteristics of this design are the constant comparison of data with emerging categories and theoretical sampling of different groups to maximize the similarities and the differences of information (Creswell, 2009, p. 13).

A call for participants was distributed for ASU undergraduate Latina and Latino JBMSHP participants to opt to participate in the study by contacting me directly via e-mail and/or telephone. The call for participation was sent via e-mail by the JBMSHP staff members to their alumni listserv, posted by me via Facebook to the JBMSHP page, via e-mail to the Tau Psi Omega Fraternity, Inc. undergraduate and alumni listservs to whom I am the academic advisor too, and in person at a JBMSHP luncheon. Through these means seven students who met the criteria of being a JBMSHP participant and current ASU undergraduate participated. There were four females and three males.

Limitations of the Study

My study had three limitations. First, this study had a small sample size and, therefore the results cannot be used to generalize or make claims about the entire population of Latina and Latino JBMSHP participants. Second, the study only conducted one-time interviews with each participant, so depth of data received is limited. Third, because this study only examined the experiences of Latina and Latino JBMSHP participants at ASU and not the entire population of current undergraduates JBMSHP participants, the results of the study cannot be used to generalize or make claims about the entire population.

Definition of Terms

To understand this research study, it is important to define terms that are discussed throughout the research.

The racial/ethnic definitions are provided and derived from the *Gender, Race/Ethnicity & Citizenship of New Doctoral Recipients* survey request coordinated by the American Mathematical Society.

American Indian or Alaska Native: A person having origins in any of the original peoples of North and South America (including Central America), and who maintains tribal affiliation or community.

Asian: A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam.

Black or African American: A person having origins in any of the black racial groups of Africa, not Hispanic or Latino.

Hispanic or Latino: A person of Mexican, Puerto Rican, Cuban, South or Central American, or other Spanish culture or origin, regardless of race.

Native Hawaiian or Other Pacific Islander: A person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

White: A person having origins in any of the original peoples of Europe, the Middle East, or North Africa.

Unknown: Individuals not solely identifying as American Indian or Alaska Native; Asian; Black or African American; Hispanic or Latino; Native Hawaiian or Other Pacific Islander; or White.

The following definition is derived from *Mathematical Reviews*, 2010 Mathematics Subject Classifications.

New Mathematical Sciences Doctoral Recipient: Are grouped by field of thesis using the Mathematical Reviews, 2010 Mathematics Subject Classifications: 1) Algebra/Number Theory, 2) Real, Complex, Functional, Harmonic Analysis, 3) Geometry/Topology, 4) Discrete Math/Combinations/Logic/Computer Science, 5) Probability, 6) Statistics, 7) Applied Mathematics, 8) Numerical Analysis/Approximations, 9) Linear, Non-linear Optimization/Control, 10) Differential, Integral, Difference Equations, 11) Mathematics Education, and 12) Other/Unknown.

The next definitions are derived from the Congressional Briefing, *Undergraduate Mathematics: Promising Recruitment and Retention Strategies to Ensure Diversity in the STEM Pipeline* given on September 22, 2009 by Regents' Professor Carlos Castillo-Chávez.

STEM: Science, Technology, Engineering and Mathematics.

Underrepresented Minorities: Underrepresented minorities include any person reported as having origins in the categories American Indian or Alaska Native, Black or African American, Hispanic or Latino, and Native Hawaiian or Other Pacific Islander.

The following definitions are derived from the Arizona State University website and individual websites of the respective units.

ASU: Arizona State University is a New American University, promoting excellence in its research and among its students, faculty and staff, increasing access to its educational resources and working with communities to positively impact social and economic development.

MCMSC: The Mathematical, Computational & Modeling Sciences Center is an ASU center that strives to create a dynamic community of quantitative scientists and mathematicians, driven to contribute to the solution of problems in the biological, environmental, and social sciences. Through flexible research and cross-disciplinary programs, the MCMSC will train a new generation of scientists whose research is driven by "solution" rather than "discipline." Armed with this mindset, the MCMSC will promote, support and encourage teams and faculty that do not hold a reductionist view of the world.

JBMSHP: The Joaquín Bustoz Math-Science Honors Program is an intense academic program that provides motivated students an outstanding opportunity to begin university mathematics and science studies before graduating high school. The program is designed to provide a successful university experience for students who are underrepresented in the mathematics and science fields and to enhance their prospects for future academic success.

MTBI: The Mathematical and Theoretical Biology Institute supports the development of students through educational, research and mentorship activities from the undergraduate to the postdoctoral level. Its programs include intensive multiple-summer research training institutes, long-term support for its alumni,

continuous research opportunities for undergraduate, graduate and postdoctoral students and opportunities for national and international visitors.

The next definitions are derived from each of their respective websites.

AMS: The American Mathematical Society, founded in 1988 to further the interests of mathematical research and scholarship, serves the national and international community through its publications, meetings, advocacy and other programs.

ASA: Since it was founded in Boston one wintry November morning in 1839, the American Statistical Association has supported excellence in the development, application, and dissemination of statistical science through meetings, publications, membership services, education, and advocacy.

MAA: It all began in 1894 with the American Mathematical Monthly - and ever since, the Mathematical Association of America has been providing mathematicians with the best expository articles, engaging problems, and articles devoted to teaching collegiate mathematics. In 1915, they became the MAA.

SIAM: The Society for Industrial and Applied Mathematics was incorporated in 1952 as a nonprofit organization to convey useful mathematical knowledge to other professionals who could implement mathematical theory for practical, industrial, or scientific use.

The last definition is provided by the *Annual Survey of the Mathematical Sciences* section housed on the American Mathematical Society website.

Data Committee: A joint committee of representatives from the AMS, ASA, MAA, and SIAM that provides guidance to the AMS staff that coordinate the *Annual Survey of the Mathematical Sciences*.

Organization of the Dissertation

This study will be organized in five chapters. Chapter 1 provides an introduction, background and need for the study, purpose of the study, research questions, research methods, limitations of the study, and definition of terms. Chapter 2 is a review of the literature relevant to the research area. Chapter 3 describes the research procedures and methodology, including the researcher's background, research design, theoretical framework, study site selection, site and subject access, description of data collection process, and data analysis procedures. Chapters 4 presents the findings. Chapter 5 concludes with study limitations and implications for practice, research, and policy.

CHAPTER 2

Theoretical Perspectives and Review of the Literature

> Based on my experience and the study of the status of Latinas/os in higher education, one factor remains clear: lack of knowledge does not mean lack of intelligence or the ability to learn and excel. In a world that moves quickly, there is little time and patience to gain knowledge other than what comes easily. It is uncomfortable for each of us to take the time to learn and appreciate the knowledge that each individual brings to the table, and yet I have learned that multiple perspectives, like multiple scientific experiments focused on solving a single problem are critical to the production of new knowledge. (Turner, in press)

Turner provided me the context for which to select the theoretical perspectives and research guiding this study. In the first section, literature related to academic capital formation is covered. In the second section, literature related to the Nora Student Engagement Model is covered. In the third section, the research is related to Latina and Latino persistence in STEM. In the concluding section, the information is on university outreach high school STEM programs.

Academic Capital Formation

St. John, Hu and Fisher (2010) describe academic capital formation (ACF) as a complex set of social processes and behavioral patterns that reinforce individual and family commitments to an actualization of cross-generation uplift. Their theory was developed by identifying claims about social processes in human capital theory (Becker, 1975), social capital theory (Coleman, 1988), and social reproduction (Bourdieu, 1972) theories. Figure 4 provides the Social Processes Integral to Academic Capital Formation Model, which St. John and Milazzo-Bigelow (2010) described as,

The building blocks of the academic capital that enables first-generation college students to break the barriers to access higher education. That included: overcoming concerns about college costs as a process related to human capital; building support networks, navigating social and educational systems, and acquiring trustworthy information to build social capital; and building personal and family college knowledge as a resource to overcome reproduction of under representation in higher education (p. 3).

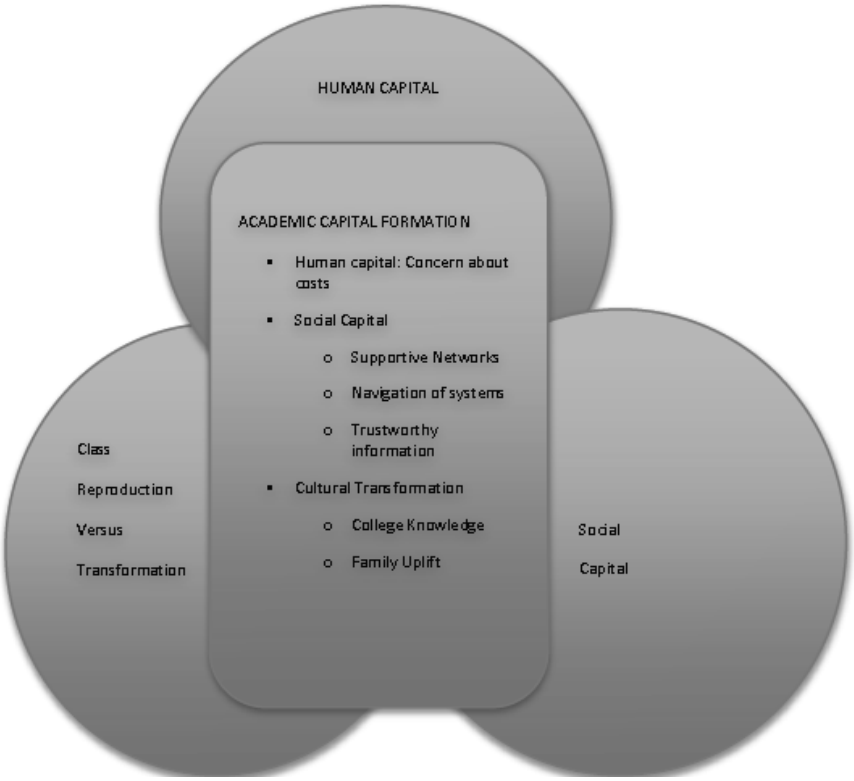


Figure 4. Social Processes Integral to Academic Capital Formation

Nora Student Engagement Model

García and Hurtado (2011) recently used Nora's (2003) Student Engagement Model in their study, *Predicting Latina/o STEM Persistence at HSIs and non-HSIs*. In this study they used the six major components of the theoretical framework when studying the persistence of Latina/o college students. The following are the six major components:

> 1. *Precollege factors/pull factors* including precollege ability, psychosocial factors, financial assistance and need, encouragement and support from family, and environmental pull factors.
>
> 2. A *sense of purpose and institutional allegiance*, which incorporates aspects of educational aspirations and commitment to attending a specific institution.
>
> 3. *Academic and social experiences*, including interactions with faculty, involvement in learning communities, social experiences, mentoring experiences, validating experiences, and experiences with the campus climate.
>
> 4. *Cognitive and noncognitive outcomes* including academic performance, intellectual development, and noncognitive gains.
>
> 5. *Goal determination and institutional allegiance*, which includes degree attainment and institutional commitment.
>
> 6. *Persistence*, or re-enrollment in an institution of higher education. (p. 7)

According to the research, the Model of Student Engagement for Latina/o students is supported by years of empirical research on the persistence of Latina/o students (Nora, 2003). Figure 5 below displays Nora's (2006) Student Engagement Model.

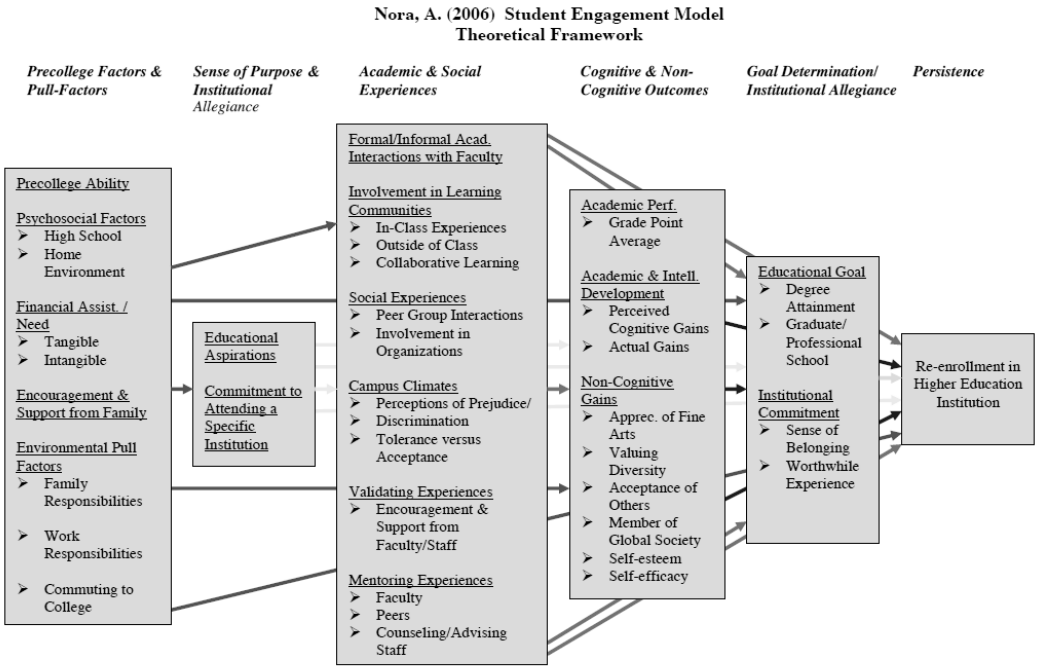


Figure 5. Nora (2006) Student Engagement Model

Latina and Latino Persistence in STEM

Reviewing research related to the persistence of Latinas and Latinos in STEM is important for understanding why the experiences of Latinas and Latinos in this particular math and science program matters. In addition, it provides the context for why an institution of higher and postsecondary education provides their services to high school students.

According to Gándara (2006),

> Access to rigorous curriculum continues to be a critical issue for Latino and other minority students….Certainly, Latino students will not go to STEM careers if they do not have rigorous preparation in math and science, but without such preparation, they are not likely to go on to college at all. (p. 231)

Gándara brings to our attention two critical issues. First, that there are Latina and Latino students being excluded from more rigorous courses, which in turn lower their post K-12 academic preparation. Second, the failure to prepare these students is derailing them from a college preparatory track.

Failure to fully engage Latina and Latino students within our curriculum is devastating as it may lead these students not to seek STEM careers or worse yet pursue a college education. Recent studies such as Museus, Palmer, Davis, and Maramba's (2011) state that Hispanics "have suffered and continue to suffer from inequalities at all levels of the STEM circuit." Their study elaborates on the overall status of underrepresented minorities in STEM and places an importance on Hispanics because they are the fastest-growing racial group in the United States.

Increasing success among not only Latinas and Latinos, but among all ethnic minority students in STEM is of importance as Museus, Palmer, Davis, and Maramba, (2011) give the following reasons,

> Including the fact that it is necessary, the economic well-being of individuals and the nation, America's competitiveness in the international marketplace, the moral and ethical obligation of educators to fight systematic inequities, and the need to adequately prepare STEM college graduates for the increasingly diverse and global STEM workforce. (pp. 5-6)

Hurtado, Cabrera, Lin, Arellano, and Espinosa (2008) also provide support to this research as their own study stated,

> By the year 2015, there will be a substantial increase in the number of racial/ethnic minorities entering college (Carnavale and Fry 1999). If the nation's colleges and universities are to graduate the next generation of research scientists, they must be aware of the number of racial/ethnic minorities in the science pipeline and make efforts to successfully recruit and retain students, as this group has great potential to influence change in the scientific workforce. (p. 190)

In addition, they provide the following statistics which they deem especially concerning given the necessary function of graduate education for those entering scientific research careers:

> Unfortunately, the rates of science baccalaureate completion for underrepresented minority (URM) undergraduates are dismal: only 24% of African American, Latina/o, and Native American students complete a science bachelor's degree in six years, compared to 40% of White students

> (Center for Institutional Data Exchange Analysis 2000). This under representation has an additional negative impact on communities of color, as URM scientists are more likely than non-URMs to study issues specific to minority communities (Nichols 1997). Among the three dominant disciplines that comprise the biomedical and behavioral science (BBS) fields—biological sciences, chemistry, and psychology—URM students represented 18% of bachelor's and 7% of doctoral degrees in 2004 (National Science Foundation (NSF) 2007). (p. 190)

University High School STEM Outreach Programs

Similar programs to the JBMSHP were sought in order to further gauge other STEM opportunities available to high school students. The literature provided programs such as the Meyerhoff Program at the University of Maryland, Baltimore County (UMBC) and the Academic Investment in Math and Science (AIMS) at Bowling Green State University. Both are similar to the JBMSHP, but different in that JBMSHP is a summer experience and not necessarily a summer bridge to their respective home institutions.

The Meyerhoff Program. Museus, Palmer, Davis & Maramba (2011) highlighted the Meyerhoff Program in their study, as a program "aimed at promoting minority college students' success" (p. 77). According to their overview,

> …was established in 1988 and is focused on increasing success among Black students in STEM; …emphasizes the four areas: knowledge and

> skills, motivation and support, monitoring and advising, and academic and social involvement (Hrabowski and Maton, 1995); …consists of summer bridge program, study groups, program community, counseling, tutoring, summer research internships, administrative and faculty involvement, community and family involvement, and mentors; selective admission by nomination; and approximately forty to sixty students are selected. (p. 79)

Also, it is stated that researchers have found this program to be associated with higher grade point averages than those of students who did not participate in the program (Hrabowski and Maton, 1995; Maton, Hrabowski, and Schmitt, 2000).

Academic Investment in Math and Science (AIMS). According to a letter from Dr. Sidney Ribeau, President of Bowling Green State University, that appeared in the *Academic Investment in Math and Science Student Handbook: The Program, The Expectations (2004)*, AIMS was created in 2001 due to the growing need for highly trained people in technology, engineering and related fields. President Ribeau stated, "the mission of AIMS is to increase the number and quality of STEM-based bachelor degree recipients, while focusing on two grossly under-represented populations—women and students of color" (p. i). In a study by Gilmer (2007) he concluded with the following summary of AIMS,

> AIMS components, such as the 5-week Summer Bridge Program, STEM Exposures, AIMS Seminar, STARS peer teaching/leaning, undergraduate research, faculty/student mentoring, help build a support system and encourage students to remain in STEM-based disciplines, strive

> for/achieve academic excellence, graduate, and seriously consider graduate study. (p. 19)

Joaquín Bustoz Math-Science Honors Program. According to the *Joaquín Bustoz Math-Science Honors Program 25th Anniversary (1985-2010) Annual Report 2010* produced by the Mathematical, Computational and Modeling Sciences Center (2011),

> The JBMSHP was founded in 1985 when 32 minority students from Phoenix-area high schools were brought to the Arizona State University (ASU) Tempe campus and immersed in an intense, learning experience in mathematics. Encouraged by the student's responses, the program content was strengthened to challenge participants with a college-level mathematics course for credit the following summer. Today, high school students from across the state of Arizona and the Navajo Nation compete for participation in the JBMSHP. As of the summer of 2010, 2,365 students have participated in the JBMSHP. (p. 3)

Prospective participants have the opportunity to be selected for up to three summers as they can apply as early as the spring of their sophomore high school year. Over 25 years the program has evolved. Also noted in their report,

> The JBMSHP is dedicated to encouraging low-income students and those who are underrepresented in the fields of mathematics and science to pursue majors in those fields while maintaining high academic standards. During the first eleven years of its existence, participants of the JBMSHP

> were students from underrepresented minority groups exclusively. In 1996, the program broadened its focus and participation was opened to all Arizona high school students meeting the JBMSHP's academic and socio-economic criteria, which also includes students who were first-generation college bound. (p. 3)

Based on the information reviewed for each program primarily on their websites all programs seek to advance the recruitment of underrepresented minorities in STEM. However, there are notable similarities and differences. A difference between the JBMSHP and the other two programs is that the JBMSHP provides three possible summer experiences where participants can enroll and complete college level mathematics and science courses during their high school years. Both Meyerhoff Program and AIMS offer courses, but they are transitional courses like AIMS Seminar I and II. Another difference is that both the Meyerhoff Program and AIMS have an intensive retention program for their participants and the JBMSHP does not appear based on the information provided to have. An additional similarity is that all three programs provide tutoring. Differences aside, these three programs combined have assisted over 3,000 students interested in STEM.

CHAPTER 3

Methodology

This chapter describes the methods used to explore the experiences of the participants and examine the research questions, including my background as it pertains to this topic, research design, study site selection, site and subject access, description of data collection process, and data analysis procedures.

My Background

It is important to express my role beyond a researcher of this particular study. The reasons I chose to explore the experiences of ASU undergraduate Latina and Latino JBMSHP participants as well as to examine how the program enhanced their math and science learning experiences are shared through the following brief biography.

I was born in downtown Phoenix and raised in a household with two parents, two older siblings, and throughout the years, different family members and friends that my parents took in for short periods of time. Neither of my parents had the chance to partake in higher and postsecondary education as young adults in México. My older brother never chose to pursue the opportunity, and my older sister has attended community college since graduating from high school. I am proud to write that she will earn her bachelor's degree in May 2012. Clearly, a culture involving the pursuit of a higher and postsecondary education was not present in my upbringing, but we were raised by example; to work hard and to always believe "*que sea lo que Dios quiera*" (that it be what God wants it to be).

My Pre-K through grade 12 educational experiences all took place in the Phoenix Elementary School District #1 and the Phoenix Union High School District. Both systems offered me many opportunities. In elementary school, I was able to participate in student government, algebra and chess clubs, speech and debate, community service events, and choir. In junior high, I attended a fine arts school in which I was actively involved. My high school years began a little differently as I was not involved in many activities.

Freshman year, I found myself struggling with my English, math, and science classes, which were a crucial part of the high school curriculum. I quickly learned how academically unprepared I was due to my previous school not providing the same classroom resources that my peers appeared to have had. I was probably the only student in my honors biology class who had never dissected an animal. During my sophomore year, instead of being involved in extracurricular activities, I began my first paid job at Pete's Fish & Chips. I worked at the restaurant throughout high school. I began to get more involved in school during my junior and senior years. I had kept in touch with my freshman honors English teacher, Mrs. Krauss, who was the first person to show interest in my college plans. Because of her questions and support I started to question my future. I sought opportunities such as, Urban League's College Connection Program, which helped me start defining my college path. Because of this program's exposure, I was introduced to the right resources that helped me apply for college,

financial aid, and for two summer transition programs that I participated prior to beginning my freshman year in college.

My college path led me to ASU and I strongly feel that this is where I was meant to be. I still remember my first class, English 101, where I was nervous about not knowing anyone. I also experienced a culture shock, as my high school had been significantly diverse. I remember breathing a sigh of relief when the African-American instructor arrived. I was no longer the only ethnic minority in the room. This was one of many opportunities that allowed me to grow tremendously as a Mexican-American man and to realize what my passions in life were. I became involved within Greek Life, specifically the academic and community service based Tau Psi Omega Fraternity, Inc. My involvement in the fraternity taught me how privileged I was to be a college student. It also provided me with community support and kept me actively involved in giving back to our community through service. I was challenged academically, as I realized early in high school that my elementary school education had not prepared me for high school. In college I was still catching up, if not making up for that early deficit. I recognized this situation and made a conscious decision to be more involved in outreach in order to help better prepare the future college students of my community.

My college experience also influenced me professionally as it introduced me to a realm of possibility that I never knew existed: higher and postsecondary education institutions as potential employers. I embarked in this experience as a

work-study student, which led to endless opportunities. The work-study position laid the foundation and raised the bar for what my professional work ethic would be and exposed me to the accomplishments that remained to be realized by our Latino/Hispanic community. One example that sparked my interest in my study was helping Latinas and Latinos pursue and finish degrees in STEM beyond bachelor degrees. Through my professional experiences I realized how underrepresented the Hispanic community is when it comes to graduation rates of STEM doctoral degrees and in having tenured faculty appointments at research intensive higher and postsecondary education institutions.

My experiences have culminated in a desire to be a catalyst for change by being involved, by advocating, and by seeking best practices. In the last few years my second cousins are becoming young adults and have started to explore their college paths. I want my work to assist them, as the work of so many others has assisted me in my own journey. There are inequalities, but it is my duty as a professional in higher and postsecondary education to remind them and anyone else that together we can persevere and accomplish goals; especially those goals we never knew could exist, such as a masters or a doctoral degree.

Research Design

In order to fulfill the purpose of this study, which is to explore the experiences of ASU undergraduate Latina and Latino JBMSHP participants as well as to examine how the program enhanced their math and science learning experiences, a qualitative research method was selected. The stories of the

participants were captured through one-on-one guided interviews of their experiences in either the five-week session or eight-week session summer program in which they enrolled in a university level mathematics course for college credit. A qualitative research method was appropriate as it is "particularly well suited to the study of diversity because it does not assume that there is one universal truth to be discovered, but rather focuses on listening to the subjective experience and stories of the people being studied" (Auerbach & Silverstein, 2003, p. 26). The method selected was grounded theory, which is a "systematic methodological approach to qualitative inquiry that generates theory 'grounded' in the data themselves" (Charmaz, 2006; Corbin & Strauss, 2008; Glaser & Strauss, 1967; Saldaña, 2009).

In order to decipher through the data, Glaser and Strauss (1967) suggest the constant comparative method which Glaser later elaborated on in 1978 and was then documented by Bogdan and Biklen (2003) in their fourth edition of *Qualitative Research for Education: An Introduction to Theories and Methods*. The steps are as follows:

1. Begin collecting data.
2. Look for key issues, recurrent events, or activities in the data that become categories of focus.
3. Collect data that provide many incidents of the categories of focus, with an eye to seeing the diversity of the dimensions under the categories.

4. Write about the categories you are exploring, attempting to describe and account for all the incidents you have in your data while continually searching for new incidents.
5. Work with the data and emerging model to discover basic social processes and relationships.
6. Engage in sampling, coding, and writing analysis focuses on the core categories. (p. 67)

In utilizing the constant comparative method, it is important to recognize that all steps are to go "on all at once," so that the "analysis keeps doubling back to more data collection and coding" (Bogdan and Biklen, 2003, p. 67). According to Glaser (1965), "the purpose of the constant comparative method of joint coding and analysis is to generate theory more systematically" (p. 437). Thus, the constant comparative method allows for the generating of theory coming directly from the data. Importantly, just as the data coding and analysis occur simultaneously, the coder (and analyst) is involved and is reflected in the coding and analysis. So, it's not the objective coding and analysis that supposedly takes place in quantitative analysis.

Site Selection

The JBMSHP was selected for its accessibility, established history, and engagement of high school students in mathematics and sciences. According to their *Math-Science Honors Program: 1985-2008 Annual Report*, "throughout its

tenure, JBMSHP has done a tremendous job in motivating some of the most creative minds of the new generation of prospective mathematicians, scientists and engineers within the State of Arizona to create a statewide community of future scholars" (p. 3). Also, the *Joaquín Bustoz Math-Science Honors Program 25th Anniversary (1985-2010) Annual Report 2010*, noted that as of the summer of 2010, 2,365 students had participated in the program and represented the State of Arizona and the Navajo Nation. Of those student participants 50% have been Hispanic and 49% of their fall 2010 JBMSHP Alumni enrolled at ASU were Hispanic.

Participant Selection

Participants in this study were selected through convenience sampling, which Auerbach & Silverstein (2003) identified as one of many grounded theory alternatives to random sampling. The final sample size of this study was a total of seven participants. There were four females and three males who varied in academic level and major. Each participant completed a demographic survey and participated in a one-on-one guided interview. A guided interview was selected in order to "elicit the participant's worldview" and allow the researcher the opportunity to be "open to pursing topics that the participants brought up" (Rossman & Rallis, 2003, p. 181).

Data Collection

Upon approval by the Institutional Review Board (IRB) at ASU the process of recruiting participants began (see Appendix E). In order to capture as

many voluntary participants as possible, multiple recruitment efforts were made, which utilized a recruitment script (see Appendix A). First, with the assistance of the JBMSHP staff members, an e-mail seeking their assistance was sent to all alumni. Second, I sent an e-mail to a multicultural campus fraternity to whom I am their academic advisor. Third, I sent an e-mail to a group of colleagues who work directly in recruitment and retention on campus. Fourth, the JBMSHP staff members invited me to attend one of their monthly student luncheons to connect and recruit with the possible participants in person.

Once participants expressed interest and in most cases their availability, I sent an individual e-mail to each participate confirming the date, time, and location that was most convenient to them for the one-on-one guided interview. The recruitment and interview period was conducted over two months. Three interviews were conducted at my office on campus and four interviews were conducted at a JBMSHP office. Before beginning each interview I thanked the participant and provided them a cover letter (see Appendix B) and demographic survey (see Appendix C) that instructed them to complete and return if they consented to the interview. Interviews lasted up to forty-five minutes. All interviews were audio recorded digitally to account for accuracy in capturing participant experiences. I took minimal notes during interviews to deter from distractions, but upon completion of interview(s) allowed time for observer comments which included, but not limited to “emotional reactions to events,

analytic insights, and questions about meaning" (Rossman & Rallis, 2003, p. 196).

The interview questions were formed with the goal of stimulating responses from the participants that would hopefully capture their voice as they told of their experiences. Based on the research questions the interview was created with three overarching themes that included the participant's personal journey, their JBMSHP experience, and their goals. These overarching themes had a set of open-ended questions (see Appendix D). As interviews were completed each audio file was individually submitted to a professional company for transcribing. As each transcription was completed the company uploaded a Word document containing a verbatim transcription. Each Word document was then read by the researcher for accuracy and as needed, read simultaneously while listening to the audio file or comparing to the field notes taken for clarification.

Data Analysis

The data analysis commenced with the reading of the hard copy transcriptions for coding. Coding followed the three basic types of coding found in grounded theory research: open, axial, and selective (Corbin and Strauss, 1990).

During open coding, I used highlighters, red pen, pencil, and hard-copy printouts as tools for the first reading as recommend by Saldaña (2009); "there is something about manipulating qualitative data on paper and writing codes in pencil that give you more control over and ownership of the work" (p. 22). The

first transcript required a few readings in order to revisit the experience of the participant. During the third reading, fourteen codes began to emerge from the approximately eighteen questions asked. And so, each transcript was read line-by-line and coded accordingly with the same tools as the first transcript in order to label and categorize the experiences.

During axial coding I incorporated the use of Microsoft Word in order to create a new file where all coded excerpts were grouped together according to their theme. At this time, eight categories were formed from the previous fourteen codes. The Word document listed the participant number, each code, the corresponding excerpt, and page citation. Then the participant number was removed and included in the page citation (i.e., 1, 3) and only the codes and their excerpts remained. This allowed me to organize my data in different ways and to start to make connections which will be my basis for generating theory.

During selective coding I read through the new Word document that contained the grouped data. Four themes emerged from the eight categories. Member checks were made individually to each participant via e-mail once coding concluded. Two of the seven participants provided clarifications and/or further details. This allowed me to narrow down the emergent themes and connections among them, so that I could start to formulate explanatory statements for a possible theory.

In summary, the data analysis was the formation of four overarching themes for this study: K-12 Educational Experiences, Family, JBMSHP

Experiences, and JBMSHP Alumni Resources. The findings on these themes, including subcategories, will be described fully in the next chapter.

Chapter 4

Findings

The purpose of this study is to explore the experiences of Arizona State University undergraduate Latina and Latino Joaquín Bustoz Math-Science Honors Program participants as well as to examine how the program enhanced their math and science learning experiences. The study was specifically designed to answer the following guiding research questions:

1. What factors do the participants perceive as contributing to their initial interest in the mathematical sciences?
2. What factors related to the JBMSHP do the participants perceive as influencing their continued interest in pursuing the mathematical sciences as a course of study?

The two overarching goals of this qualitative study are 1) to understand and capture the experiences of Latina and Latino program participants from "their point of view and in their own words" (Merriam, 2001); and 2) to determine from the participant's perspective, whether the program promotes a sustained interest in pursuing mathematical sciences as a potential college major and career. Based on the narrative data from this study, implications as to the contributions of the JBMSHP to the production of a Latina and Latino pipeline in the mathematical sciences will be discussed. I will also address the program's potential as a model for engaging, recruiting, retaining, and increasing the mathematical sciences pipeline for Latinas and Latinos as well as all underrepresented minority groups.

Seven program participants who self-identify as Hispanics took part in this study. Primary criteria for selection were to be a Latina or Latino, an Arizona State University undergraduate, and a JBMSHP alumni. In order to keep their comments anonymous and maintain confidentiality, each student provided a pseudonym to identify their interview. Because of the nature of grounded theory and qualitative research, it is important to learn more about each of the participants. The following chapter sections present individual profiles of study participants (see Table 1) and the themes and sub-themes emerging from analysis of the interview data. Information collected from a demographic survey that was administered to each study participant prior to each interview (see Appendix C) also contributed to the development of these profiles. Analysis of the narrative data resulted in the identification of four overarching themes.

Participant Profiles

The following table provides a synopsis of each participant that met the criteria. To be noted is that all but one participant participated in the JBMSHP two or more years. So, between the seven participants we have a total of 16 summer experiences in the JBMSHP. In addition, all but one participant was not currently employed. Of those employed only two did not currently work on an ASU campus.

Table 1

Participant Profiles from Demographic Survey Questionnaire and Interview

Name	Participant Profile
Barb	Female; junior; 21; identifies as Hispanic; first generation college student; mother graduated from high school, but neither parent graduated from college; currently employed part-time on campus; prior to attending the JBMSHP wanted to major in engineering, did not want to attend graduate school, wanted to become an engineer; current major is chemical engineering, 3.41 GPA, wants to attend graduate school to pursue a masters, wants to be a chemical engineer in the mining field; and participated in the JBMSHP in 2007, 2008, 2009.
Tino	Male; junior; 21; identifies as Hispanic; first generation college student; both parents graduated from high school, but neither parent graduated from college; currently not employed; prior to attending the JBMSHP wanted to major in computer systems, wanted to attend graduate school and pursue a masters, wanted a good paying job; current major is electrical engineer, 2.54 GPA, still wants to attend graduate school and pursue a masters, wants a good paying job with electrical engineering; and participated in the JBMSHP in 2007, 2008, 2009.

Table 1 (continued)

Participant Profiles from Demographic Survey Questionnaire and Interview

Miguel	Male; senior; 23; identifies as Hispanic; first generation college student, neither parent graduated from high school or college; currently employed part-time at a retail store; prior to attending the JBMSHP wanted to major in pre-med, wanted to attend graduate school and pursue an MD, wanted to become a physical therapist; current major is exercise and wellness: health promotion, 3.00 GPA; still wants to attend graduate school and pursue an MD; wants to pursue a career in health communications; and participated in the JBMSHP in 2006.
Carolina	Female; senior; 22; identifies as Hispanic; not a first generation college student, both parents graduated from high school and college; currently employed part-time on campus; prior to attending the JBMSHP was undecided on future major, wanted to attend graduate school and pursue a PhD, and pursue a career in something with biology; current major is mathematics and biology, 3.11 GPA, still wants to attend graduate school and pursue a PhD, wants a career in something with mathematics; and participated in the JBMSHP in 2010 and 2011.

Table 1 (continued)

Participant Profiles from Demographic Survey Questionnaire and Interview

Susie	Female; senior; 23; identifies as Hispanic; first generation college student, both parents graduated from high school, but not from college; currently employed part-time on campus; prior to attending the JBMSHP wanted to major in interior design, did not want to attend graduate school, undecided on career objective; current major is art education, 3.10 GPA, wants to attend graduate school and pursue a masters, wants to be an art teacher; and participated in the JBMSHP in 2006 and 2007.
Jazmin	Female; sophomore; 19; identifies as Hispanic; first generation college student, neither parent graduated from high school or college; currently employed part-time at a restaurant; prior to attending the JBMSHP wanted to major in nursing, wanted to attend graduate school and pursue both an MD and a PhD, wanted to become a pediatrician; current major is psychology, 3.41 GPA, still wants to attend graduate school and pursue both an MD and a PhD, wants to have a PhD in psychology and work as an adolescent psychologist or become a professor or a pediatrician; and participated in the JBMSHP in 2009 and 2010.

Table 1 (continued)

Participant Profiles from Demographic Survey Questionnaire and Interview

Javier	Male; sophomore; 19; identifies as Hispanic; not a first generation college student, both parents graduated from high school and father graduated from college; currently employed part-time on campus; prior to attending the JBMSHP wanted to major in math, wanted to attend graduate school and pursue a masters, wanted to be a college professor; current major is applied math, 3.69 GPA, still wants to attend graduate school, but wants to pursue a PhD, wants to be a professor at a university; and participated in the JBMSHP in 2008, 2009, 2010.

Of the seven participants, only one currently holds a GPA of less than a 3.00. Only two are not first generation college students. All participants were sophomores or higher student level. Six of the seven participants were currently employed part-time. Four of six currently employed part-time worked on campus and had started by working at the JBMSHP or their parent center the MCMSC.

Table 2

Demographic Survey Data

Participant	Pseudonym	Student Level	GPA	Age	First Generation	Employed
1	Barb	Junior	3.41	21	Yes	Yes
2	Tino	Junior	2.54	21	Yes	No
3	Miguel	Senior	3.00	23	Yes	Yes
4	Carolina	Senior	3.11	22	No	Yes

Table 2 (continued)

Demographic Survey Data

5	Susie	Senior	3.10	23	Yes	Yes
6	Jazmin	Sophomore	3.41	19	Yes	Yes
7	Javier	Sophomore	3.69	19	No	Yes

Based on their responses to the *Demographic Survey Pre & Post Joaquín Bustoz Math-Science Honors Program Objectives*, of all of the participants only three had no intention of attending graduate school. After the JBMSHP they do want to attend graduate school and others' plans went unchanged. The majority of majors after their JBMSHP experiences have become better defined and so have their career objectives. All but one participant has no immediate intention to continue in a STEM related field.

Table 3

Demographic Survey Pre & Post Joaquín Bustoz Math-Science Honors Program Objectives

Pseudonym	**Pre & Post JBMSHP**	**Major**	**Attending Graduate School**	**Graduate School Objective**	**Career Objective**
Barb	Pre	Engineer	No	N/A	Engineer
	Post	Chemical Engineer	Yes	Masters	Chemical Engineer in the mining field
Tino	Pre	Computer Systems	Yes	Masters	Good paying job
	Post	Electrical Engineer	Yes	Masters	Good paying job in Electrical Engineering

Table 3 (continued)

Demographic Survey Pre & Post Joaquín Bustoz Math-Science Honors Program Objectives

Miguel	Pre	Pre-Med	Yes	MD	Physical Therapist
	Post	Exercise and Wellness: Health Promotions	Yes	MD	Health Communications
Carolina	Pre	Undecided	Yes	PhD	Something related to Biology
	Post	Mathematics & Biology	Yes	PhD	Something related to Mathematics
Susie	Pre	Interior Design	No	N/A	Undecided
	Post	Art Education	Yes	Masters	Art Teacher
Jazmin	Pre	Nursing	Yes	MD/PhD	Pediatrician
	Post	Psychology	Yes	MD/PhD	Adolescent Psychologist OR Professor OR Pediatrician
Javier	Pre	Math	No	Masters	College Professor
	Post	Applied Math	Yes	PhD	University Professor

Themes

The participants gave me the opportunity to listen to their experiences as alumni of the Joaquín Bustoz Math-Science Honors Program. Their Latina and Latino voices shed light to their personal journeys, their experience(s) in the JBMSHP, and their goals. In sharing of themselves, four themes materialized: K-12 Educational Experiences, Family, JBMSHP Experiences, and JBMSHP

Alumni Resources. The following sections provide their lived experiences in each theme.

Theme 1: K-12 Educational Experiences

All of the participants shared their early educational experiences which were composed of very diverse experiences. For example, participant experiences included involvement in specialized programs such as, gifted K-8 curricular enrichment, advanced placement courses, completion of community college courses, magnet programs, a binational education experience, impacts of teachers, and self realizations.

Specialized Programs. Some of the participants mentioned specialized programs in their interviews and credited these experiences as defining moments that impacted their academic careers. For example, Barb said, "I never thought about not going to college. …ever since I was in sixth grade I've been in gifted programs, so I've always been in the whole scholarly world, I guess you could say." She then added, "I guess the fact that somebody told me that I was gifted from early on. I guess that helped me, because I was always like, well I can do it, so why not. Mentally I can handle it, so why [not] do it, it's in my ability."

Tino on the other hand had a defining moment that solidified his desire to be challenged through math. He said,

> It started when I was accepted into a Curricular Enrichment, CE, back in elementary school, because we had to take this test to show if we were gifted. I didn't even know it was a test. It was just questions I liked

> answering them, and apparently I did good because then I had CE all the way through elementary school to middle school.

As for Miguel, his experience allowed him to grow with an emerging program. He said,

> At first, it was like an elective class which we were basically assistants to the athletic trainer. We would assist at games, football games or different sporting events. Then they would teach us an intro to sports medicine on how to tape ankles, how to—basic injuries, like the main ones. How to deal with them and how to do a treatment with some stuff and when people are dehydrated—all the general stuff, the things that you mostly see on a high school athletic program. It started like that, but then I got lucky ‘cause my third year of high school the school did a program with another high school in the district. They started what—it was called a Sports Medicine Academy, which was a second level of that first class that I took. I would actually go to another—to that other high school in my district and I would take that class. That was really, really interesting, ‘cause I learned a lot.

Teacher Impact. The impact of a teacher can also be a defining moment for a student. The students describe their teachers as “being able to catch their attention” and come across as “pretty cool” or “amazing.” Three students spoke highly of the impact teachers had on them. For example,

Barb still can recall how she became interested math in elementary school. She said,

> I still remember, which is weird that I remember the day, I don't remember what date it was but I remember the day because we had a substitute teacher. We were in math in sixth grade and we learned how to find the area of a circle, because before that we would just count the little squares inside the shape and we're like, okay, the area is this or for a square and a rectangle, that was easy, multiply the length of this side. I was like, oh my gosh, that's amazing. When she would explain stuff, it just caught my attention. I always wanted to know more.

Carolina had a similar story, however, her experience was from high school years. Carolina said, "well, I became interested in science when I was in high school. I had a teacher, his name was Mr. Brock and he was amazing." Carolina felt that Mr. Brock was amazing "because he loved what he did" and because he was able to engage her through a subject that she started getting into. For example when she took AP Biology with Mr. Brock, she recalls that he,

> He was always—for the experiments, he would always like bring different things and—even though they were not in the course, he would like, "Okay, let's do these. What are you guys interested on?"

He brought new ways of thinking to the classroom and also engaged her and her classmates on what their interests were.

Self Realizations. The participants were asked what they attributed their success in school to. The majority responded with being able to recognize their academic strengths (i.e., math and/or science) and then focus primarily on those strengths. Others responded with having a keen sense of which teachers to approach for recommendations which allowed them to apply to programs such as the JBMSHP. One participant responded that he attributed his success in school to having started his K-12 education in México which allowed him to have a comparison between the Mexican and U.S. educational systems.

Barb said, “I knew trying to get one [recommendation] from my English teacher wasn’t going to work, because she didn’t like me very much and because I didn’t like English.” Instead Barb approached her science and math teachers. Her intuition allowed her to navigate the system in her favor. Knowing herself also contributed to her success. For example she said, “well, self-rewarding, there’s a lot of things where I’m like, I actually get it and it makes sense. That’s a reward for me, just learning more and actually understanding what’s going on.”

Carolina, Susie, and Jazmin shared similar stories on why they liked mathematics and the sciences. Of math, Carolina said, “I can go through all of the process and get the actual answer. For me, that’s good.” Susie identified her experience earlier in life, describing how she began to enjoy studying math in middle school. She discovered that puzzling through equations was preferable to other classes: “It was easy for me to figure out in my head ‘cause like reading and English are not my subjects.”

Jazmin made her realization in high school, when she took community college courses. She said, “I really liked biology and I really liked math in high school. I really enjoyed my AP biology class.” However, she later recalls her experience taking a non-mathematics and non-science courses and shared, “I liked hitting the books. I liked studying. Now, tell me about literature and not so much. I took AP literature too, and I was like, ‘Oh, no, never again.’ I really liked science. I mean, I don’t really know what attracted me to it.”

Tino on the other hand used this knowledge to question his career objectives. He said,

> Usually when it involves English [or] writing papers, it takes me a while… because I’m not a big English fan, whatever. Math and all the science and stuff, that comes easy to me, so I would rather pick something easy and get a good paid job at it or do something hard and maybe get a good job, because English, I don’t know what you would be.

Javier, a binational student, was able to gauge the differences between the U.S. education system and that of México. He said, “…the school system here is lower than in México, so when I came here, oh, what's going on? It's easy.” His experience allowed him feel as though he could manage the curricular demands of the US even as an immigrant.

Theme 2: Family

All of the participants shared stories of their families' involvement in their college path. Sub themes that emerged are 1) encouragement, 2) financial assistance, and 3) higher and postsecondary education influence.

Encouragement. All of the students recalled a story of their parents' words of encouragement. Some may appear hands off and others more direct, but it was apparent during the interviews that the support was well received and understood. Some of the participants acknowledged that their parents might have been limited in their ability to help, as they had never attended college. Even the parents of those who were not first generation college students were limited in their assistance since they had completed their college education outside of the United States.

Barb, the first participant recalls,

> Only one of my parents graduated from high school, so my parents couldn't really help us a lot in schoolwork, but they did make us do it. They would set apart time and make sure that we did our homework. I remember once in second grade, I had a random homework and I didn't do it because I forgot about it, and my mom woke me up at like six in the morning before school started because she found it, that it wasn't done, and she set up this little table and desk that we had *[Laughter]* for little kids. She's like, you have to do this before you go to school and she woke me up early just to do it. I mean, they've always encouraged us to do it,

> but since they didn't know how to do some of our school work or even how to—even the whole process of going to school and getting better at stuff, they couldn't help us with that, but they encouraged us, I guess you could say.

Susie and Jazmin had a similar recollection to that of Barb's. Susie feels that her family gave her "the strength" she needed and "support." Jazmin recalls, "They encouraged me, but at the same time I feel like they had a hard time with it. They really didn't know how to help me other than the fact that they knew that if I kept up my grades it would help me a lot."

The participants were aware and sensitive to the fact that their parents were not able to guide them through college. Even though they could not relate, their parents did inquire about their progress. For example, "They were always on me," Tino said, "…they would always check up on me and stuff like, 'Hey, how's this college thing going?' I'm like, 'Oh, I'm getting it done.'"

The families' encouragement contributed to the independence of the students. Tino alluded to having to "take it upon myself," and Miguel also felt that he never had to depend on his mom. When it came to academic or school questions and stuff like that, I did it on my own. That kind of prepared me for when I came to college 'cause I was on my own, so it wasn't that big of a deal for me to do that. They're kinda like not too involved with my whole college—they weren't really involved with my college path, but they were always supportive

with everything that I did. I do maintain that communication and I always tell them—they always know what I'm doing.

Carolina and Javier had slightly different stories since they were not first generation college students. Both of their parents attended college, however, it was not in the United States. Carolina was pushed to be a "professional some day" and Javier was "always told to go to college."

Financial Assistance. Family income data was not requested of the participants, however a sub theme of finances emerged as participants recognized that this was a way that their families supported them. Whether it was by filing the Free Application for Federal Student Aid (FAFSA), questioning the affordability of their child's college plan, or by applying for parent loans, a majority of the students acknowledged their families' support.

Barb remembers how her parents "always try and get their taxes done really early, like even now because they know I have to get my FAFSA in and if I don't get it in before March, then I get less money for financial aid." Jazmin's parents were more or less worried that she would not be able to afford a university like Arizona State University. She remembered, "my parents wanted me to save up money and go to community college. Once they realized how much money I had racked up in scholarships, they were pretty okay with it." Susie's parents were also concerned at first, but as she learned about scholarships and shared the information with her parents, they became very encouraging. Now that she attends university they have learned of additional ways in which they can assist

her. Her parents help with her financial needs by "taking out a parent loan to, like, giving me grocery money."

Higher and Postsecondary Education Influences. The previous two sub themes touched on ways that the participants' parent(s) assisted them with their verbal encouragement and financial support. Both were influential factors. This sub theme of higher and postsecondary education influences also emerged, but included extended family and also words that were less encouraging. Many of the decisions that the participants made in relation to their educational goals were influenced by how their parent(s) and some of their extended family members felt about higher and postsecondary education. Barb, Carolina, and Javier all shared stories of how they were directly influenced by their immediate family members. Barb was directly influenced by her brother who was at a community college. She remembered,

> I knew I wanted to become an engineer when my brother was going to school for—he was in community college and he was going for draft, like draft design or I think that's what it's called, but he wanted to go to community college and then come to ASU to be an architect. I knew that architects and civil engineers worked really close together, and then that's when I started thinking about an engineer because the whole drawing thing didn't catch my attention but the whole engineering part of it did.

Carolina's immigrant family inspired and motivated her to be successful in school. She said,

> They are the goal to get to where I need to get. I mean, my mom was a lawyer when she was in Columbia and she came here to clean houses. That was huge—and she did it to give us a better life. For that, I feel like I don't want to let her down.

Javier had a similar experience as his college educated parents also emigrated from another country. Their educational attainment taught him "if you want to have a good job or do whatever you want, you can go to a college. Otherwise, you're going to be just in a store as a cashier or something."

Tino, Susie, and Jazmin cited their uncles as an influence in their academic pursuits. Tino was introduced to the JBMSHP by his uncle Ernie who had been a participant when, according to his uncle, the two current JBMSHP coordinators had been enrolled in the program as well. Susie's uncle also attended the program and he encouraged her and other family members to join JBMSHP. He was a big influence since Susie considered a career in math because of him. She said,

> Then I was just like, 'Well, math is important, so I need to stick with that.' I did math for a year. I was like, 'Well, what in math do I want to do?' I thought about that for a while and decided, like, my uncle is a math teacher…I can try that.

Jazmin knew she "was going to go to college" and that is what she "worked for all of high school." However, an uncle who graduated from nursing school when she

was a senior in high school also assisted her. She said, “he was the one who kind of was telling me…this is what you need to do.”

Tino, Miguel, and Jazmin also had interesting stories about their parents’ strong words of encouragement. Their parents had not attended an institution of higher or postsecondary education. Tino’s dad “was a military guy and he would always say that, it's either college or go to the military.” This led Tino to make his decision, “…I’ll choose college. I'm okay with that.” His mother motivated Miguel in a different manner. She was not able to attend high school or college so she always encouraged Miguel to try things she never had the opportunity to do. He remembers,

> She has sacrificed her whole life to see me happy, and I think that’s my way to thank her, by reaching all my goals and being successful in life. I’m about to graduate this semester. I’ll be the first one in my whole entire family to graduate from my university, so I’m pretty excited for that….I’m not going to give up because it’s my future but I also have my family’s expectations of me to be successful. I think that was one of my biggest motivations, being successful and just making sure that my family sees me be successful ‘cause that’s not only my goal but that’s also my family’s goal.

Jazmin is also a first generation college student and has a military father like Tino. However, her academic interests were less positive in her household due to his service in Afghanistan. She recalls,

> My dad went to Afghanistan, so I realize …he saw a lot of things over there. When he came back, a lot of the stuff that I went through in the last two years in my high school pertained a lot to what he had seen in Afghanistan. A lot of the things that I wanted to do, all the things I would talk about, he was usually against. He was always against me going to four year institution. He was always against me staying on campus. He was always against anything that would pretty much make it seem like I had a good life….That I had opportunities. It seemed like…things were just being handed to me, and so that was one of the things that we always differed on. I knew I was earning everything I was doing, but to him it was just, like, me taking all these opportunities…without really doing much hard work.

Thankfully, Jazmin was able to balance his support with that of her mother's who she felt was "always very supportive." Her mother "never said no," but did help her plan to "have a backup."

Theme 3: Joaquín Bustoz Math-Science Honors Program Experiences

A section of the interview questions prepared focused on the participants' experiences in the Joaquín Bustoz Math-Science Honors Program. The following sub themes emerged from the accounts shared by the participants: 1) Love-Hate Relationship; 2) Community Building (A Sense of *Familia*); 3) Rigorous Standards; and 4) College Immersion.

Love-Hate Relationship. Of the seven participants only one did not have an immediate mixed reaction to their experiences in the JBMSHP and only one did not attend the program more than once. Barb's immediate reaction of her experience summarizes the undertone of all of their recollections, "I hated it, but I liked it." This appears to be the case with most of the students, but for various reasons. The feeling of it being "scary" because they were from a small town; the feeling of being "overwhelmed" by the volume of work; the feeling of wanting to "cry and stuff" because it was the first time away from their parents; the feeling of wondering "what am I doing?" and the feeling of just wanting to leave, were common sentiments among the participants.

Miguel was the only participant who did not reapply for another summer. His experience reflected that conflicting love-hate relationship that most had. He blames the program for developing a disliking towards math. He said,

> After the program, I disliked math. I couldn't stand math. Even after I came back …it was my only D ever in my high school career. It was in my math class my senior year. I was just so fed up with math…it was so overwhelming, 'cause I've always been…good at math but I was always on my own pace. The program was way too fast for me, so I was always left behind. I guess that made me start disliking the math class and the math homework and all that. It just kind of made me realize that I couldn't learn in a faster pace than what I had— that I had my own pace.

Finding a pace was also necessary for Susie and Javier in order to not feel overwhelmed. Javier recognized that,

> Sometimes people get overwhelmed with the homework. That happens, but I never overworked myself. If I didn't finish, I didn't finish and did good on the tests and got a good grade in the class. Other people were like, oh, I want to finish this, and they didn't stay [in the program] for five weeks.

Susie was one of those participants that almost did not stay for the five weeks. In fact, she remembers calling her mom,

> "Mom, can you come pick me up?" My mom would not come and pick me up. She reminds me to this day, "Had I gone to go pick you up," she goes, "I think it would have been the biggest mistake of your life." She always tells me, she was like, "But, it was pretty funny to hear you crying and to hear you complaining about the program." She always tells me…, "I made you finish it. Just remember that."

As bleak as the situation may appear from their experiences, Carolina remembers that it "felt like it was kind of like an adrenaline rush." Barb summarized the love-hate experience, "it's hard, it's fun and I guess it's life changing."

Community Building (A Sense of *Familia*). Building relations with others appears to be important among the participants for various reasons. Some of those reasons are: being able to help each other; to know there are others they can trust; to push themselves further; to be with others who share common

interest; or to be part of a program that encompasses all these reasons and makes them feel that they are part of a family.

Tino was able to benefit from the JBMSHP because it provided him a "group of people that I know that I can trust." Otherwise he felt that he would have been a "shut-in, staying at home, not really knowing anyone." In addition to the social benefit, Tino also saw the academic benefit of his new community. He felt that he really needed to "get up top because all around you is people that are good, too." This was not what he experienced in high school where "you can be average and still be in honors and get A's and stuff."

Carolina and Susie liked the JBMSHP community because they were comfortable with the other participants. Carolina said,

> It felt good, because even though I felt down for a couple of days…we talked mathematics 24/7. I would talk to these people and we would joke about math things and we will have all of these groups. We would laugh and everything—things that I wouldn't be able to do in high school.

Susie was apprehensive about attending the program for a second summer. She recognized the academic challenges but felt comfortable will her fellow participants because they shared a common interest in math. This was something she had not experienced in high school.

The sense of community they shared and everyone's openness "no matter where you came from or no matter how much you know about a subject" was something Miguel appreciated. Barb and Carolina also felt this sense of

community. Barb recalls how “they don’t say, you’re part of the MSHP family, they tell you, you’re MHSP now… and they kind of treat you like it.” Carolina agreed and felt that it is “very special and very important.” Having a sense of belonging among their peers is important to the participants because it became their home away from home.

Rigorous Standards. Participants can take part in one of three experiences each summer. There are two five-week sessions and one eight-week session. Regardless of which session they were placed in (determined by their individual placement exams), they all shared stories of the demands placed upon them and how they gained useful skills because of them. Miguel remembered a typical day in the program,

> We would have class every day from 8:00 in the morning. We’d have to wake up by 7:30 and eat breakfast and go to class. Before class, we had two hours of tutoring, I think. We would just do our homework— or we were supposed to do our homework the day before, but if we had any questions we would leave those till that time and then the tutors would help us out. Then the class would start for the next two hours and that was a two-hour lecture. Then we had more tutoring after that and then I think that was everything that was required. Then after that it was free time, but only if you were doing good in your homework. I think the only day I didn’t have mandatory tutoring for me was the first day.…in order not to have mandatory tutoring you have to get a 90 percent or better on your

> homework. Each homework assignment was over 100 problems... I had a really hard time. Oh, and I guess if you didn't meet that grade on your homework you had to stay for more mandatory tutoring for the rest of the day. So literally, it was math from like 7:00 in the morning till probably like 4:00, plus going home or to the dorm and doing more homework. I think that was my biggest issue with it. That it was way too much for me.

Even though this was a typical day for many of the participants they also learned valuable lessons. For instance Jazmin felt that, although the program was difficult, it prepared her for college.

> You learn a little bit more. Definitely, like, having to put the effort—if there's anything that I got out of that program is definitely that putting the effort is worth it, and it's definitely, like, it's like your best way to go. Although, like, I would say it's a lot more extreme in the program. College is not as extreme to it, at least ASU level is not as extreme to the program, but it does prepare you. When I came out here and I took math after that, I was like, "No." Like, my math class, it wasn't a breeze 'cause I wouldn't say the material was easy. I just wanna say, like, the homework, like having less homework and then have recitation. Like understanding—like being able to understand that, okay, if I made it through that program, I can make it through this math class. That's pretty much what it was.

She was able to take her new skills and apply them to her undergraduate experience. Barb also recognized that she was held up to a new set of standards and that the program "taught me how to discipline myself."

College Immersion. All of the participants discovered through their experiences that the JBMSHP not only exposed them to ASU, but to higher and postsecondary education. They were able to take university level courses, live on a university campus, and for one student, to break a misconception.

Barb felt as though she was taught "how hard you're going to have to work." Miguel was able to transition to a regular semester math course when he enrolled at ASU. He remembers, "I had so many expectations of that math class that when it came down to it, it wasn't the same experience. It wasn't as bad because class was only twice a week and homework wasn't that much."

Jazmin's experience prepared her for having a lot of homework once she entered college. For instance she shared,

> I think definitely the homework. Just realizing that there was going to be—I mean, maybe it was a tad bit excessive in the program, but you do come to realize that you will have more—you will have to do more work to get through college. It's not just, like, all fun and games, memorize this, memorize that. Memorize this formula, get this down. You actually have to study. You actually have to do the work. You have to be willing to put in the time to excel.

The JBMSHP allowed the participants to transition their high school study habits to those of a college student. Javier recalls, “in college, your classes are extended, so you learn the same things, but in longer period of time. You get used to that pace of college other than high school that everything was easy.” Carolina felt the program was good “because it taught me that it’s possible to do everything if I study so hard.”

Tino, Miguel, Susie, and Javier all enjoyed getting a taste of both ASU and the City of Tempe. Tino felt that the program gave him a “taste of college life” which he was then able to compare to his home town of Casa Grande which he felt was “really boring.” Javier believes that the program also tried to “sell” Tempe to those participants that lived outside the city. His conclusion, “It worked for me. I stayed here.” Miguel and Susie also enjoyed getting to know the campus. Miguel thought that the best aspect of being on campus a year before applying to ASU was “just getting that experience of living on campus and actually getting to know the campus and getting the atmosphere of a college classroom and how it’s going to—basically you get a preview of how it’s going to work once you come here.” Susie recalls how she enjoyed her free time, “I would explore… campus a little bit. Like finding out the library and just walking around campus.”

According to the majority of the participants their experiences in the program allowed them to make decisions pertaining to their higher and postsecondary education goals. Miguel said, “…the fact that it was a program at

the university, so I figured that it was going to help me with deciding what I wanted to do after high school." Carolina used the program as a measure to determine if she would be able to "handle" college. Susie and Jazmin discovered, through their individual experiences, that ASU could be a place for them. For instance Susie thinks that the "program was the first step in going to college." This step allowed her to face her fear as she "was really scared" to attend ASU. Jazmin came to the program with two assumptions. The first that she would first start at a two year college and the second what she thought ASU was about. After attending the program she realized that she "didn't wanna go to two year college" because through the program she found that she "really liked ASU." In addition she was able to break her misconception of ASU and their support of Hispanic students. She shared,

> The program really kind of opened my eyes to ASU. Before, all I had really known was, "Oh, ASU, party school, whatever," you know? When I came to the program, there's so much more to ASU than people realize. I do—I've come to understand that ASU does a lot, at least from my perspective, does a lot to have Hispanics—to allow Hispanics to come and study here, to aid Hispanics in going through college. They have a lot of resources and that's what I really liked about it.

Theme 4: Joaquín Bustoz Math-Science Honors Program Alumni Resources

What does it mean, as Barb described, to be "MSHP now?" Well, all of the participants shared their account of what it is to be a JBMSHP Alumni. Based

on their experiences it means: 1) to have continued communication about the program, 2) to have financial assistance opportunities through the program and outside of the program, 3) to have a community space on campus, and 4) to have JBMSHP staff support.

Continued Communication. The staff members maintain communications with their alumni base. According to Tino, "they've always been on track on keeping us up to date, sending us emails, things like that, because once we were part of it we were part of like the list of things that they can help us out with."

These e-mails range from "things going on with ASU to different resources" that alumni such as Miguel found beneficial. One of the e-mails put him in touch with ASU marketing and promotions. They were looking for models for pictures. He said, "I actually did respond to that e-mail and I did get into the pictures and I have all these pamphlets and stuff about that photo session at home that my family is really proud of."

Financial Assistance Opportunities. Another form of continued communication is the financial opportunities made available to alumni both within and outside of the program. Financial opportunities include the S-STEM scholarship, paid research opportunities, and paid tutoring opportunities. Tino and Javier both benefited from the S-STEM scholarship, which they were able to apply for as JBMSHP alumni currently enrolled at ASU and majoring in

mathematics or science. Tino says, “it helped out a lot” and that he was “very thankful” for the $4,000 per academic year award.

Both Carolina and Javier were made aware of paid research opportunities. Carolina was able to do an internship with the Western Alliance to Expand Student Opportunities (WAESO) which helped her both economically and taught her a lot. Javier was able to participate in the Mathematical and Theoretical Biology Institute (MTBI) which provided him room, board, and a $3,000 stipend. Javier also benefited by connecting with prominent campus faculty whom he is currently doing research with. He also learned about his current degree goal, the Bachelor of Science in Applied Mathematics for the Life and Social Sciences (AMLSS).

The majority of the participants were currently employed part-time and worked on campus. Barb, Tino, Carolina, and Susie all worked as tutors for the JBMSHP. They help other students have similar experiences that were made available to them. Carolina and Susie learned from those opportunities that they enjoyed teaching. Barb also turned that experience into a future employment opportunity. According to her,

> The guy looked at my resume and he saw that I had tutored for MSHP… He was happy I had tutoring experience but he was a lot happier that I had tutoring experience with the Math-Science Honors Program because he knew that their standards were really high.

Community Space. The majority of the participants spoke about the community space created and maintained for their use. They are provided computer access, free tutoring, free printing, microwave, refrigerator, and occasional luncheons. Beyond the convenience of having these resources, one student highlighted the knowledge that was shared. Susie spoke about how they help each other because they can be in the same lab and know each other. Barb agreed and says that "95 percent of the chance there's somebody else in there that you're friends with and you can get help for stuff. I mean, we ask each other for help all the time." In addition to them assisting each other, participants like Tino are able to help newer alumni who recognize him from being a JBMSHP summer tutor. He shared that at times during the school year the paid tutor is not available so, "they would come to ask me for help because I've already been in the class and like, all right that's cool." Jazmin concurred with the benefits of the community space echoed by her peers, but also added that it is "nice to see all those familiar faces. Especially older students that are getting ready to graduate or that you get to see graduate."

Staff Support. The staff support provided to participants as alumni was recognized. Susie shared, "They really change people's lives. I mean, they touch people's lives in ways that I don't know if…anybody ever really tells them how important they are."

Susie elaborates on why she feels the staff is important,

> Well, like I said, they help us by giving us the resources... They send out scholarships. They're just here to talk, too. Sometimes the advisors aren't, like, the best people to go to. I go for psychology, you know, personally for psychology. The other reason I go to my advisor is to make sure I'm on the right track. I don't go and ask them questions. I actually come and talk to Cindy and she kind of lays it out for me. She does a better job at making me understand, like, how my choices are going to affect me in the long run. I see them as my advisors, not really all the other ones. I see them as my advisors.

Barb also mentioned their willingness to assist and connect the students with appropriate university services. She said,

> They're always there, so if we ever need their help with anything, we need them to go over a paper for us, they'll help us edit it. Our résumés, …every time I update it, I'll go and ask Cindy and Beca, "Does this look okay, what can I do to make it better?" If we have questions about anything, we can go and ask them. And even though they might not be experts at it, they'll tell us how we can find out more. Like, okay, call this person or you have to get in contact with that department.

Summary

The participants shared their personal journeys, experiences in the Joaquín Bustoz Math-Science Honors Program, and goals through interviews. In addition, each completed a demographic survey. After all phases of data collection were

completed, each data source was coded separately, analyzed, and studied to identify common categories and patterns. Four major themes emerged and were identified as such:

1. K-12 Educational Experiences which provided a foundation for wanting to challenge themselves academically;
2. Family which provided them guidance through different stages of their college path;
3. Joaquín Bustoz Math-Science Honors Program Experiences which further exposed them to higher mathematical courses and immersed them in a higher and postsecondary education environment; and
4. Joaquín Bustoz Math-Science Honors Program Alumni Resources which is integral to the current undergraduate experiences of most participants.

The following chapter presents a final discussion of the research questions and findings. The chapter concludes with study limitations and implications for practice, research, and policy.

CHAPTER 5

Discussion

The purpose of this study is to explore the experiences of Arizona State University undergraduate Latina and Latino Joaquín Bustoz Math-Science Honors Program participants as well as to examine how the program enhanced their math and science learning experiences. The study was specifically designed to answer the following guiding research questions:

1. What factors did the participants perceive as contributing to their initial interest in the mathematical sciences?
2. What factors related to the JBMSHP did the participants perceive as influencing their continued interest in pursuing the mathematical sciences as a course of study?

Major Findings

There were four major findings in this study:

1. K-12 educational experiences which provided a foundation for wanting to challenge themselves academically;
2. A family that provided guidance through different stages of their college path;
3. JBMSHP experiences that further exposed them to higher mathematical courses and immersed them in a higher and postsecondary education environment; and

4. JBMSHP alumni resources that were integral to the current undergraduate experiences of most participants.

The major findings are discussed through the following sections: 1) Research Questions, 2) Theoretical Frameworks, and 3) Theory Development.

Research Questions

The first guiding question sought to explore what factors the participants perceived as contributing to their initial interest in the mathematical sciences. Both their K-12 educational experiences and family were frequent answers to this question. All of the participants shared stories of being part of an accelerated program during K-12; had a teacher that engaged their desire to seek a mathematical or scientific answer; or just felt inside as though math and/or science came naturally to them. In addition, their families contributed, not necessarily to their initial interest in mathematical sciences but to raising self-motivated students who valued having someone to talk to even if they could not relate to their academic journey.

The second guiding question sought to explore what factors related to the JBMSHP the participants perceived as influencing their continued interest in pursuing the mathematical sciences as a course of study. Based on the participants' stories, their experiences in the program and their alumni involvement have encouraged them to pursue the mathematical sciences as a course of study. The reasons varied, but the Community Building *(*A Sense of *Familia)* that transpired during their summer experiences carried over into their

alumni experiences since the program provided community space and most of all the continued staff support.

Theoretical Frameworks

The research study was not created to test St. John and Fisher's (2010) Academic Capital Formation or Nora's (2006) Student Engagement Model, but both provided additional lenses through which to view and interpret the experiences of the participants in the program and how the program may have enhanced their math and sciences experiences. In this way, this study contributes analytically to our understanding of what factors contribute to student success. Through the use of a grounded theory approach I was able to identify factors that contribute to explaining student success.

Through Nora's (2006) Student Engagement Model, I was able to interpret the data (participant experiences) based on the model factors. For precollege factors/pull factors the data showed how families can affect students positively and negatively. In multiple cases the participants recognized the encouragement and support from family as positively because of their ability to at least be a listening ear. However, for one participant it was a pull factor because the dialogue between her and her father was less cordial and the discussion of her university life was not a topic of discussion at home. Attending the JBMSHP gave all but one participant a sense of purpose and institutional allegiance. The subtheme of *Community Building (A Sense of Familia)* emerged from their feelings of how they were meant to feel during the program and after. The

JBMSHP provided students with both an academic and social experience and are documented in the subthemes of *Rigorous Standards* and *College Immersion*. Through these experiences the majority of the students felt prepared both academically and mentally for a future transition into an institution of higher education. The *Joaquín Bustoz Math-Science Honors Program 25th Anniversary (1985-2010) Annual Report 2010* documented one of the many cognitive and noncognitive outcomes. The outcome being academic performance as determined by grade point averages. According to their figures JBMSHP Alumni have higher grade point averages than Non-JBMSHP Alumni. For example in the College of Liberal Arts and Sciences a JBMSHP Alumni at ASU has an average of 3.11 and a Non-JBMSHP Alumni at ASU has a 2.96. (p. 12). Their report also documents the factors of goal determination and institutional allegiance and persistence. As of spring 2010 the "total ASU degrees earned by JBMSHP Alumni is 904" (p. 13).

Through St. John and Fisher's (2010) Academic Capital Formation theory, I was able to interpret the data in theme 3 and theme 4 which directly represented the participants experiences in the JBMSHP. As participants their human capital increased as they were able to alleviate the concern about costs as they became more knowledgeable of financial aid and financial opportunities available to them. A broad example would be the importance of FAFSA and a specific example is student employment opportunities on campus which four of them currently hold. During their summer experience(s) and as alumni students their

social capital increased as they identified that they now had supportive networks (i.e., their peers), were better informed through workshops provided to them of how to navigate the systems not limited to admissions and financial aid, and that the information received was trustworthy such as that received from the JBMSHP staff members. The increases in human capital and social capital led to their cultural transformation as it provided them college knowledge and lastly served as family uplift. Examples of family uplift occurred in both extended family (uncle to niece) and within immediate family (sister to sister) encouraging the other to apply and attend the JBMSHP. By viewing the data through the lens of human capital, social capital, and cultural capital it became obvious that the JBMSHP does improve the overall academic capital formation of its participants.

Again, the study was not created to test either theoretical framework, but they have aided in supporting the notion that the experiences of ASU undergraduate Latina and Latino JBMSHP participants has enhanced their math and science learning experiences positively.

Theory Development

Based on all the participants the JBMSHP did enhance their math and science experiences. Javier's experience in particular stood out because his participation trajectory resembled a possible emergence of a Latina and Latino STEM Pipeline. He participated in the JBMSHP in 2008, 2009, and 2010. During this time he met Regents' Professor Carlos Castillo-Chávez who introduced him to his current major: Bachelor of Science Applied Mathematics for the Life and

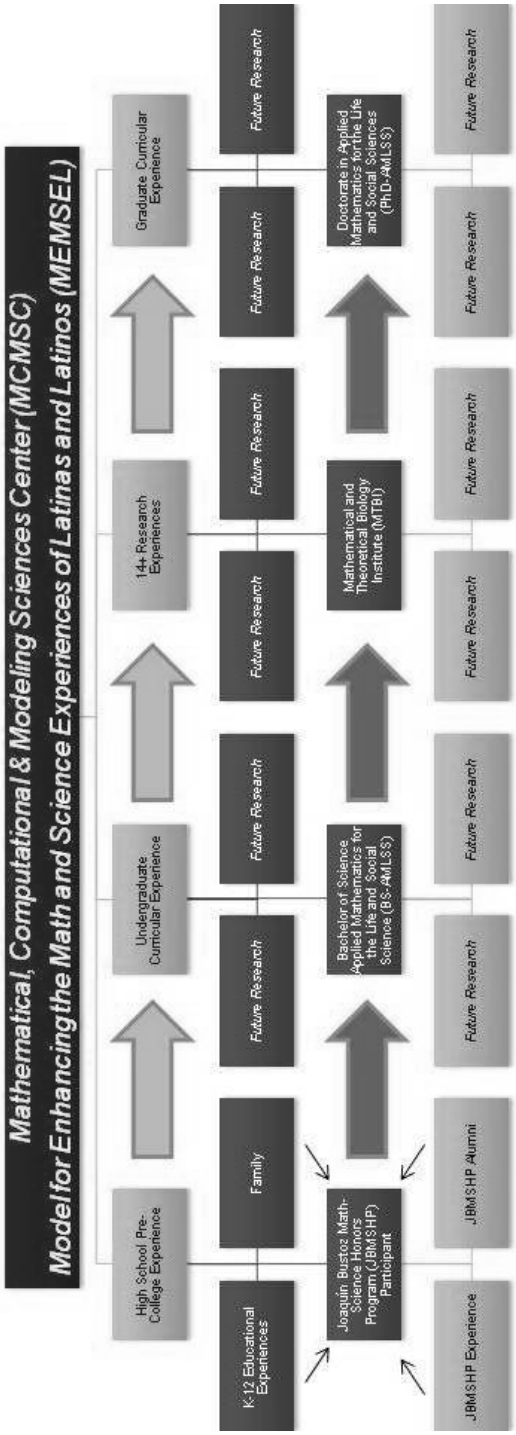
Social Science. He was also introduced to MTBI and was allowed to apply a year early (after his freshmen year as opposed to his sophomore year) in 2011. He also met his current faculty mentor with whom he is gaining research experience. In summary, Javier recognizes all these events in two meaningful ways: 1) that they are all under Regents' Professor Carlos Castillo-Chávez who is the Executive Director of MCMSC who houses all these student opportunities and 2) that everything at ASU [for him] is in this floor [referring to the 5th floor of Physical Sciences, A-Wing where MCMSC is physically housed]. Based on the positive experiences of these Latina and Latino participants the model of a *MCMSC Model for Enhancing the Math and Science Experiences of Latinas and Latinos* emerged, which is conceptualized in *Figure 6*.

The figure depicts the stages in which Latinas and Latinos interested in STEM can potentially engage the MCMSC. The center allows for participants to potentially navigate in and out of the pipeline starting the summer after their high school sophomore year through doctorate experience including both a curricular and/or research opportunity. Also, the pipeline depicts how a student may seamlessly enter and continue through their doctoral studies without ever having to exit.

This study and its findings represent the first entry point which is High School Pre College Experience (the JBMSHP) in the pipeline model. Undergraduate Curricular Experience (Bachelor of Science in Applied Mathematics for the Life and Social Studies), 14+ Research Experience

(Mathematical and Theoretical Biology Institute), and Graduate Curricular Experience (Doctorate in Applied Mathematics for the Life and Social Studies) are marked for future research.

Figure 6. Mathematical, Computational & Modeling Sciences Center (MCMSC) Model for Enhancing the Math and Science Experiences of Latinas and Latinos (MEMSEL)



Limitations

The study has three limitations. First, this study has a small sample size and therefore, the results cannot be used to generalize or make claims about the entire population of Latina and Latino JBMSHP participants. Second, the study only conducted one-time interviews with each participant, so depth of data received is limited. Third, because this study only examined the experiences of Latina and Latino JBMSHP participants at ASU and not the entire population of current undergraduates JBMSHP participants the results of the study cannot be used to generalize or make claims about the entire population.

Implications

Based on the experiences shared, the JBMSHP does enhance math and science experiences of the participants. The enhancement is positive during the program through their rigorous standards and also as alumni through the support and commitment of the staff to the students' academic success. If the JBMSHP and ASU wish to contribute to the creation of a skilled and diverse 21st century workforce, I recommend the following:

First, at the state level the MCMSC has the opportunity to be a pipeline for Latina and Latino students interested in pursuing a STEM degree. In listening to the experiences of the students, only two were aware of the many offerings of the MCMSC. If streamlined, the MCMSC could create a seamless transition that would impact students from their sophomore year in high school through their doctoral studies. Institutional support from the administration should be sought in

order to expand the JBMSHP in the State of Arizona through the utilization of all ASU campuses and ASU Colleges which would support the mission of the program to outreach and integrate first-generation college students and underrepresented populations throughout Arizona and the Navajo Nation.

Second, at the national level the JBMSHP through this study as shown that it supports Latinas and Latinos pursuing a STEM related degree. As such, institutions dedicated or considering supporting and advocating programs for the advancement of underrepresented populations in STEM should implement a JBMSHP. The efforts of the JBMSHP can be replicated as the elements of offering college courses, tutoring, an on-campus living experience, college presentations, and staff support which are all part of their experience pre and post program are achievable. Elements that cannot be controlled for are K-12 Educational Experiences and Family as they vary by participant.

Future Research

Future research would further elaborate on the suggested *MCMSC Model for Enhancing the Math and Science Experiences of Latinas and Latinos* in order to account for the participant experiences in each of the different opportunities. Another possibility would be to work with other researchers, such as Caroline S. V. Turner who has conducted research on MTBI in order to determine if a continuous and seamless pipeline can be created while examining if there are experiences. In addition, growing this study to encompass the experiences of all underrepresented minorities would be preferred in order to determine the impact

of the JBMSHP and the MCMSC on the cultivation and increase of underrepresented populations in the mathematical sciences.

Conclusion

A model for further enhancing the math and science experiences of Latinas and Latinos developed from this grounded research study. The findings of this study are important not only because they tell the experiences of an underrepresented and underserved population in science, technology, engineering, and mathematics, but because the Joaquín Bustoz Math-Science Honors Program is proven to be successful in fulfilling its mission as stated on their website:

> To provide an intense academic program that provides motivated students an outstanding opportunity to begin university mathematics and science studies before graduating high school, …to provide a successful university experience for students who are underrepresented in the mathematics and science fields and to enhance their prospects for future academic success. (2012)

I hope that reading the experiences of other Latinas and Latinos will inspire future generations of Hispanics to pursue a career in mathematical sciences and help them realize that they are not alone in the pursuit of their dreams.

References

Academic Investment in Math and Sciences (2004). *Academic Investment in Math and Science Student Handbook: The program, the expectations*. Bowling Green State University.

Academic Investment in Math and Sciences. (2012). Retrieved February 22, 2012, from http://www.bgsu.edu/offices/aims/

American Mathematical Society. (2012). *Annual Survey of the Mathematical Sciences*. Retrieved February 22, 2012, from http://www.ams.org/profession/data/annual-survey/survey-reports

American Mathematical Society. (2012). Retrieved February 22, 2012, from http://www.ams.org/about-us/about-us

American Statistical Association. (2012). Retrieved February 22, 2012, from http://www.amstat.org/about/index.cfm

Arizona State University. (2012). Retrieved February 22, 2012, from http://newamericanuniversity.asu.edu/about/

Auerbach, C. F. & Silverstein, L. B. (2003). *Qualitative Data: An Introduction to Coding and Analysis*. New York: New York University Press.

Bogdan, R. C. & Biklen, S. K. (2003). *Qualitative Research for Education: An introduction to theories and methods*. Boston: Allyn and Bacon.

Castillo-Chávez, C. (2009). *Undergraduate Mathematics: Promising Recruitment and Retention Strategies to Ensure Diversity in the STEM Pipeline*. Retrieved from http://mcmsc.asu.edu/files/Castillo-Chavez_Congressional%20Briefing%2009-22-09.pdf

Creswell, J. W. (2009). *Research Design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: SAGE Publications, Inc.

Gándara, P. (2006). Strengthening the Academic Pipeline Leading to Careers in Math, Science, and Technology for Latino Students. *Journal of Hispanic Higher Education*, *5*(3), 222-237.

García and Hurtado (2001). *Predicting Latina/o STEM Persistence at HSIs and non-HSIs*. Retrieved from http://heri.ucla.edu/nih/?c=presentations

Gilmer, T. C. (2007). An Understanding of the Improved Grades, Retention and Graduation Rates of STEM Majors at the Academic Investment in Math and Science (AIMS) Program of Bowling Green State University (BGSU). *Journal of STEM Education, 8*(1-2). Retrieved from http://www.bgsu.edu/downloads/provost/file49754.pdf

Glaser, B. G. & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for qualitative research*. Chicago: Aldine Publishing Company.

Glaser, B. G. (1965). The Constant Comparative Method of Qualitative Analysis. *Social Problems, 12*(4), 436-445.

Hurtado, S. & et al (2008). Training Future Scientists: Predicting First-year Minority Student Participation in Health Science Research. *Research in Higher Education, 49*, 126-152.

Joaquín Bustoz Math-Science Honors Program. (2012). Retrieved February 22, 2012, from http://mshp.asu.edu/

Mathematical and Theoretical Biology Institute. (2012). Retrieved February 22, 2012, from http://mtbi.asu.edu/

Mathematical Association of America. (2012). Retrieved February 22, 2012, from http://www.maa.org/subpage_5.html

Mathematical, Computational & Modeling Sciences Center. (2012). Retrieved February 22, 2012, from http://mcmsc.asu.edu/

Mathematical, Computational and Modeling Sciences Center (2011). *Joaquín Bustoz Math-Science Honors Program 25th Anniversary (1985-2010) Annual Report 2010*. Arizona State University.

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education*. California: Jossey-Bass.

Meyerhoff Scholars Program, The. (2012). Retrieved February 22, 2012, from http://www.umbc.edu/meyerhoff/

Museus, Palmer, Davis, & Maramba, (2011). Racial and Ethnic Minority Students' Success in STEM Education. In Ward, K., & Wolf-Wendel, L. E. (Eds.) *ASHE Higher Education Report, 36*(6). Retrieved from http://lib.asu.edu/

National Science Foundation (2011). *President Obama Honors Outstanding Science, Math and Engineering Mentors*. Press Release 11-246. December 14, 2011. http://www.nsf.gov/news/news_summ.jsp?org=NSF&cntn_id=122273&preview=false

Rossman, G. B., & Rallis, S. F. (2003). *Learning in the field: An introduction to qualitative research*. Thousand Oaks, CA: Sage Publications, Inc.

Saldaña, J. (2009). *The Coding Manual for Qualitative Researchers*. Los Angeles: SAGE Publications, Inc.

Society for Industrial and Applied Mathematics. (2012). Retrieved February 22, 2012, from http://www.siam.org/about/

St. John, E. P., Hu, S., & Fisher, A. S. (2011). *Breaking Through the Access Barrier: How academic capital formation can improve policy and higher education*. New York: Routledge.

St. Johns, H. & Milazzo-Bigelow (2010). *College for Every Student: A study of academic capital formation in exemplary rural schools*. Retrieved from http://www.collegefes.org/pdf/MichiganSummaryFinal.pdf

Strauss, A. & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. London: Sage.

Turner, C. S. V. (In Press). Mentoring Latinas/os in higher education: Intentional cultivation of talent. In R. Winkle Wagner, P. J. Bowman, & E. P. St. John (Eds.) *Expanding postsecondary opportunity for underrepresented students: Theory and practice of academic capital formation, Vol. 26, Readings on Equal Education*. New York: AMS Press, Inc.

APPENDIX A

RECRUITMENT SCRIPT

The Experience of ASU Undergraduate Students who Participated in the MSHP Prior to Enrollment

I am a graduate student under the direction of Professor Caroline S. Turner in the Division of Educational Leadership and Policy Studies at Arizona State University. I am conducting a research study to evaluate the transition of MSHP participants from their high school graduation to their undergraduate years at Arizona State University.

I am recruiting individuals to take a short demographic survey and also to interview, which will take approximately 45 minutes. Interviews involve audiotape and audiotapes will be kept for approximately 2 years or until the final project (dissertation) is completed. Audiotapes will be kept in my office at ASU in a locked file cabinet. Participants must be 18 or older.

Your participation in this study is voluntary. If you have any questions concerning the research study, please call me at (480) 965-3774.

APPENDIX B

COVER LETTER

The Experiences of Latina and Latino Joaquín Bustoz Math-Science Honors

Program Past Participants

Date

Dear Participant:

I am a graduate student under the direction of Emeriti Professor Caroline S. Turner at Arizona State University.

I am conducting a research study to evaluate the impact of the Joaquín Bustoz Math-Science Honors Program on Latina and Latino past participants now enrolled as undergraduates at ASU.

I am recruiting individuals to take a short demographic survey and also to interview, which will take approximately one hour.

Your participation in this study is voluntary. You can skip questions if you wish. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. You must be 18 or older to participate in the study.

Your participation will be used to determine how successful the Joaquín Bustoz Math-Science Honors Program is and possibly help realize how those successes can be implemented in other institutions of education. There are no foreseeable risks or discomforts to your participation.

Your responses will be anonymous. The results of this study may be used in reports, presentations or publications but your name will not be used.

I would like to audiotape this interview. The interview will not be recorded without your permission. Please let me know if you do not want the interview to be taped; you also can change your mind after the interview starts, just let me know. Audiotapes will be kept for approximately 2 years or until the final project (dissertation) is completed. Audiotapes will be kept in my office at ASU in a locked file cabinet.

If you have any questions concerning the research study, please contact the research team at: Dr. Caroline S. Turner at input cell phone #. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects

Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

Return of the questionnaire will be considered your consent to participate.

Sincerely,

Gabriel Escontrias, Jr.

APPENDIX C

DEMOGRAPHIC SURVEY

Demographic Survey to be completed by Latina & Latino ASU Undergraduate Students who have participated in the Joaquín Bustoz Math-Science Honors Program Prior to Enrollment at ASU

1. Pseudonym _____

2. Current Student Level at ASU (*Circle One*)

Freshman Sophomore Junior Senior

3. Current Age (*Circle One*)

18 19 20 21 22 23 24 25 26 27+

4. How do you label yourself? (*Circle One*)

African American American Indian Asian American
Hispanic

White International Other: _____

5. Has either of your parents graduated from high school? (*Circle One*)

Yes No

If so, which parent? (*Circle One*)

Mother Father Both

6. Has either of your parents graduated from college? (*Circle One*)

Yes No

If so, which parent? (*Circle One*)

Mother Father Both

7. Are you currently employed? (*Circle One*)

Yes No

8. If employed are you part time or full time: (*Circle One*)

Part time (34 hours or less) Full time (35+ hours/wk)

9. If employed, where?: _____

The following questions are meant to be reflective:

10. Major prior to participating in the Joaquín Bustoz Math-Science Honors Program:

_____

11. Prior to participating in the Joaquín Bustoz Math-Science Honors Program did you intend on attending a graduate school? (*Circle One*)

Yes No

12. Prior to participating in the Joaquín Bustoz Math-Science Honors Program what was your graduate school objective? (*Circle One*)

MD PhD Masters

Other: _____

13. Prior to participating in the Joaquín Bustoz Math-Science Honors Program what was your career objective:_____

The following questions are meant to be addressed in the present context:

14. Current major: _____

15. Current GPA: _____

16. Current graduate school intention? (*Circle One*)

Attending Not Attending

17. Current graduate school objective? (*Circle One*)

MD PhD Masters

Other: _____

18. Current career objective: _____

APPENDIX D

STUDENT INTERVIEW QUESTIONS

Interview Questions for Latina & Latino ASU Undergraduate Students who have participated in the JBMSHP Prior to Enrollment at ASU

Personal Journey

1) Tell me a little bit about yourself.

2) Tell me about your college path.

3) What strengths and qualities would you say have assisted you through your college path?

4) Describe for me your family's involvement in your college path.

5) How did you first become interested in science/science-related subjects?

6) When/how did you know that an academic/career path in science was what you wanted to follow?

JBMSHP

7) While you were in high school what prompted you to seek a summer research program?

8) What prompted you to seek out this particular program?

9) Tell me about your experience in the Joaquín Bustoz Math-Science Honors Program.

10) What aspect of the summer program did you find most valuable?

11) Reflecting on your past participation in the Joaquín Bustoz Math-Science Honors Program, describe any incidents that prompted you to question your academic choices and/or career interests.

12) Reflecting on your past participation in the Joaquín Bustoz Math-Science Honors Program, describe any incidents that reinforced your academic choices and/or career interests.

13) How has the Joaquín Bustoz Math-Science Honors Program assisted you from when you first participated through now?

14) Describe your overall experience with Joaquín Bustoz Math-Science Honors Program?

15) What advice would you give other Latina/o students thinking about applying to the Joaquín Bustoz Math-Science Honors Program?

Goals

16) Tell me about your ultimate career goal.

17) How did you decide on this goal?

18) What has assisted you the most thus far in reaching this goal?

19) Describe any assistance that Joaquín Bustoz Math-Science Honors Program may have given you in reaching this goal? ASU?

20) What advice would you give to other Latina/o students that are thinking about majoring in a STEM discipline?

21) What does it mean to you to be a Latina/o pursuing an education and/or career in science?

Conclusion

22) Is there anything else that you would like to share with me?

APPENDIX E

ASU INSTITUTIONAL REVIEW BOARD APPROVAL

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Caroline Turner ED
From:	Mark Roosa, Chair Soc Beh IRB
Date:	01/18/2012
Committee Action:	**Exemption Granted**
IRB Action Date:	01/18/2012
IRB Protocol #:	0902003743A001
Study Title:	The Experiences of Joaquin Bustoz Math-Science Honors Program Latina/o Past Participants

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.