

Científicos Latinxs: The Untold Story of Underserved Student Success in STEM Fields of Study

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ABOUT THE COVER IMAGE: The image, “Hummingbird Zero,” is by Chilean artist, Liliana Wilson, who now resides in Austin, Texas.

The Mayans are considered to be among the world's earliest Indigenous mathematicians to develop the concept of zero, which they depicted as a shell-shaped symbol. As a concept,

zero plays a very instrumental role in mathematics. Zero serves as a place holder and a symbol for nothing, the absence of any quantity. Mayan numerals consisted of only three symbols: zero, represented as a shell shape; one, a single dot; and five, a horizontal bar.

We chose to represent the *científicos* Latinxs in this study with the symbol of a hummingbird, because Indigenous cultures such as the Mayas, Aztecs and Tainos viewed them as magical, sacred creatures known for their incredible, swift flight ability and for their prized attributes such as valor, persistence, endurance, beauty and acumen.

AUTHORS' NOTES:

- 1. The term, Latinx, was employed to be gender-neutral and inclusive of the Latina/o community.**
- 2. The authors express appreciation to all of the Latinx STEM graduates who contributed the essays analyzed in this study. Appreciation is also extended to Dr. JoAnn Canales, Founding Dean of Graduate Studies, Texas A&M Corpus Christi, for her assistance in recruiting some of the STEM graduates who wrote the essays.**

EXECUTIVE SUMMARY

Given the significant underrepresentation of Latinx students in STEM fields of study, this knowledge essay addresses a research void regarding the factors and experiences which contribute to the success of Latinx students in STEM. This report features a qualitative study of 14 Latinx STEM graduates who wrote an essay/*testimonio* about their journey to earning a STEM degree.

Employing Latinx students' own voices and experiences, the study was guided by two research questions:

- What is the experience of Latinx students who have gained access to and completed a STEM degree (i.e., challenges faced, helpful learning experiences, sources of support and encouragement, etc.)?
- What are the personal attributes, as well as academic, social, and cultural factors and collegiate experiences that propel Latinx students to successfully earn a STEM degree? In other words, what characterizes the metastory of Latinx student success in STEM?

The study findings revealed that Latinx STEM success was fostered by:

1. Participating in STEM high-impact practices.
2. Obtaining diverse forms of financial support.
3. Receiving validation from significant others.
4. Employing their own assets.
5. Participating in Latinx-centered STEM social and academic activities and organizations.
6. Benefitting from Latinx family cultural pedagogics inherent in students' home contexts.

The study illuminates a newly-fashioned counter-story of Latinx STEM student achievement that shatters conventional thinking about the markers of student success.

Introduction

The term, scientist, was never used in South Texas because no one had witnessed anyone living his or her life as a scientist. But even with the lack of knowledge of what it entailed to be a scientist, I feel my upbringing in a Latino family prepared me to become a scientist. (Rodolfo Jimenez, p.163)

How is it possible to become a scientist if you have never even heard the term, if you don't know anyone who is a scientist, or if you have never been provided the information necessary to become a scientist? So many in the Latinx community face such a predicament and, yet, little is known about how Latinxs, especially those who are first-generation and low-income, manage to develop a science identity and succeed in STEM fields of study. Much can be learned from the experiences of Latinx STEM graduates who, despite formidable life challenges, are able to persist and to ultimately earn a degree in fields where they are exceedingly underrepresented. What is the secret to their success? What can we learn from their journey into a STEM field of study?

Purpose and Research Questions

With this knowledge essay we seek to fill a void regarding the success of Latinx students in STEM making use of their own voices and lived realities. Accordingly, we conducted a study to illuminate the academic and life journeys of 14 “*científicos* Latinxs” (Latinx scientists) who completed a STEM degree in diverse areas of mathematical and scientific study.

Specifically, the analysis addressed the following research questions:

- What is the experience of Latinx students who have gained access to and completed a STEM degree (i.e., challenges faced, helpful learning experiences, sources of support and encouragement, etc.)?

- What are the personal attributes, as well as academic, social, and cultural factors and collegiate experiences that propel Latinx students to successfully earn a STEM degree? In other words, what characterizes the metastory of Latinx student success in STEM?

STEM Inequities and Deficit Perspectives

By 2020, there will be approximately four million STEM jobs available in the United States (UnidosUS, n.d.). This prospect represents a significant opportunity that may be missed unless Latinxs increase their participation and completion rates in STEM education. STEM fields of study have been key areas where Latinxs have not fared well, and a number of inequities need to be considered to explain underrepresentation.

Inequities in STEM Participation and Degree Completion

Inequities in Latinx student STEM participation and degree completion continue to persist. A report from the American Institutes for Research (2012) indicated that: “Women, racial and ethnic minorities and persons with disabilities are underrepresented in the STEM disciplines. Collectively, these demographic groups represent the largest untapped STEM talent pool in the United States” (p. 1). The implications are serious and can impact average earnings of workers from the most underrepresented groups—women, Blacks and Latinxs. Even when controlling for educational attainment, STEM workers earn more (on average) than those in non-STEM jobs (Funk & Parker, 2018). Latinxs are also underrepresented in STEM occupations relative to their share in the U.S. workforce. The Pew Research Center (Funk, 2018) reported that the share of Hispanics in STEM occupations increased from 4 percent in 1990 to 7 percent today, a figure that is significantly below the roughly 18 percent Latinx share of the U.S. population.

Structural Inequalities

College access and completion can be impacted by structural inequalities. For example, the Pew Research Center (Funk & Parker, 2018) reported that 23.5 percent of Hispanics were living in poverty and 23.7 percent were uninsured. Latinx children have been found to be more than twice as likely to be poor compared to their white counterparts. Patricia Gándara (2010) noted that after white students Latinxs are the most segregated group in America and experience triple segregation by race/ethnicity, poverty and language. Students from low-income family backgrounds tend to do poorly in school and are usually found in schools with inferior resources (Valenzuela, 1999). These types of schools are inadequately supported with regard to classroom equipment, books, and AP courses which impact the quality of schooling students receive. Further, Latinx students in segregated schools and communities lack access to peers from the mainstream U.S. culture, inhibiting their understanding of the norms, standards, and expectations of the broader society. In many instances, students rarely come into contact with anyone who has gone to college or who intends to go, almost assuring that aspirations to attend college will never materialize (Conchas, 2006; Valenzuela, 1999; Zambrana & Hurtado, 2015).

Racialized, Deficit Views about Underserved Student Populations

Societal views about Latinxs and other underserved student populations have commonly employed racialized, deficit-based views based on widely held, spoken and unspoken assumptions. These include racialized stock stories that Latinx parents and communities do not value education, including the belief that low-income students and their communities are academically inferior (Rendón, Kanagala & Bledsoe, 2018; Solorzano & Yosso, 2002; Yosso, 2005). These master narratives are firmly entrenched and difficult to overturn. Some of the deficit language employed in these narratives is that underserved students are: “culturally

deprived,” “at risk,” and/or “marginal learners.” Absent from this entrenched grand narrative are asset-based perspectives that focus on Latinx cultural wealth and community strengths that students employ to transcend their socioeconomic circumstances, build on their instinct to survive and to excel in education (Conchas, 2006; Valenzuela, 1999; Volpp, 2000; Valencia, 2010; Moll et al. 2001; Yosso, 2005; Rendón, Nora & Kanagala, 2014; Zambrana & Hurtado, 2016).

Theoretical Framework

The study was informed by two asset-based theories: community cultural wealth (Yosso, 2005) and validation theory (Rendón, 1994; Linares Rendón & Munoz, 2011).

Community Cultural Wealth Theory

Tara Yosso’s (2005) community cultural wealth model represents “an array of knowledge, skills, abilities and contacts possessed and utilized by Communities of Color to survive and resist macro- and micro-forms of oppression” (p. 77). Employing a Critical Race Theory lens, Yosso posits that cultural wealth comes in the following forms of capital:

1) aspirational - “holding on to hope in the face of structured inequality and often without the means to make such dreams a reality” (p. 77);

2) linguistic-“intellectual and social skills attained through communication experiences in more than one language and/or style” (p. 78);

3) familial - “cultural ways of knowing in the immediate and extended family that maintain a healthy connection to community and its resources” (p.78);

4) social - “networks of significant others and community resources who provide instrumental and emotional support to navigate through institutions” (p.78);

5) navigational - “ability to maneuver social institutions which were not created particularly for Communities of Color “ (p. 79); and

6) resistant - “oppositional behaviors brought forth when Communities of Color recognize and challenge social inequities” (p. 79).

Rendón, Nora and Kanagala (2014) validated Yosso’s (2005) model and added four more Latinx student *ventajas/assets* and *conocimientos/ways of knowing* that students employ to become survivors, overcome obstacles and push themselves to complete college: *ganas/perseverance*, ethnic consciousness, spirituality/faith and pluriversal (see Table 1).

TABLE 1: LATINX STUDENT *VENTAJAS Y CONOCIMIENTOS*¹

<i>VENTAJAS/ASSETS</i>	<i>CONOCIMIENTOS</i> ² / <i>FUNDS OF KNOWLEDGE</i> ³
<i>Aspirational</i>	<ul style="list-style-type: none"> • Able to set high aspirations • Able to recognize value of education • Able to remain hopeful about the future
<i>Linguistic</i>	<ul style="list-style-type: none"> • Ability to use two or more languages to communicate and to form relationships with others • Employing diverse forms of communication skills in multiple contexts
<i>Familial</i>	<ul style="list-style-type: none"> • Modeling the strength and determination of the family • Ability to use knowledge gained through the value of family <i>consejos, respeto, testimonios, y educación</i> • Validation & encouragement from siblings, parents, relatives
<i>Social</i>	<ul style="list-style-type: none"> • Ability to create social networks • Ability to make new friends and to form new relationships
<i>Resistant</i>	<ul style="list-style-type: none"> • Ability to resist stereotypes and combat microaggressions • Ability to overcome hardships, such as poverty and lack of resources
<i>Ganas/Perseverance</i>	<ul style="list-style-type: none"> • Able to develop inner strength, become self-reliant and determined to succeed • Able to recognize and embrace the sacrifices that must be made to attend college

¹ Rendón, Nora, & Kanagala (2014)

² Anzaldúa (2005)

³ Moll, Amanti, Neff & Gonzalez (2001)

<i>Ethnic Consciousness</i>	<ul style="list-style-type: none"> ● Having cultural pride ● Exhibiting pride in attending a HSI ● Having a deep commitment to Latino community – “Giving Back” ● Being focused on the betterment of the collective whole
<i>Spirituality/Faith</i>	<ul style="list-style-type: none"> ● Turning to faith in God/ Higher power ● Having a sense of meaning and purpose ● Understanding the importance of gratitude, goodness and compassion
<i>Pluriversal</i>	<ul style="list-style-type: none"> ● Ability to operate in multiple worlds (college, peers, work, family, native country) and diverse educational and geographical contexts ● Ability to hold multiple and competing systems of meaning in tension in diverse social and educational contexts

Validation Theory

Laura I. Rendón’s (Rendón, 1994; Linares Rendón & Munoz, 2011) validation theory provides an asset-based approach to working with students in a way that recognizes and affirms students as knowers who are capable of college-level work and that builds supportive relationships between validating agents and students. Validation theory stresses the importance of affirmation, support and encouragement from in- and out-of-class validating agents (family members, peers, faculty, student affairs staff, mentors, coaches, advisers, etc.). Validation is an enabling, confirming and supportive process initiated by in- and out-of-class agents that fosters academic and personal development (Rendón, 1994). There are two forms of validation:

- Academic — when in- and out-of-class validating agents take action to assist students to trust their innate capacity to learn and to acquire confidence in being a college student and
- Interpersonal — when in- and out-of-class validating agents take action to foster students’ personal development and social adjustment.

Validation, when administered early in students’ transitions to college, and consistently throughout their college experiences, may be the key to helping students get involved and believing they can learn and achieve their goals.

Method

The current qualitative study employed two methodological tools to collect and to analyze data. The two approaches included *testimonios* and *counter-story telling*.

Testimonios

To illuminate the story of Latinx success, Latinx STEM graduates were invited to write a *testimonio*/personal story (Latina Feminist Group, 2001) about their journey into a STEM field of study. *Testimonios*, a Chicana and Latina feminist methodology, was employed as a key research method. In the classic volume, *Telling to Live: Latina Feminist Testimonios* (Latina Feminist Group, 2001), the *testimonio* methodological tool is presented to acknowledge voices and experiences that have been historically marginalized. A key aspect of a *testimonio* is that it generates knowledge and theory through the documentation and explication of life experiences.

A purposeful sample of Latinx STEM graduates was recruited to write an autobiographical essay/*testimonio* about their path toward a STEM degree. These *testimonios* are featured in the book, *The Latino Student Guide to STEM Careers* (Rendón & Kanagala, 2017). While Latinxs were given wide latitude to express their stories, guidance to write their narratives was also provided. Latinx STEM graduates were asked to relate their stories to include personal background information, their STEM major and where they earned the degree, how they paid for college, what helped them to survive the first year of college, how they overcame obstacles, if they attended graduate school and obstacles faced and overcome there, rewarding aspects about STEM, and advice they would give to future Latinx STEM students.

Accordingly, 14 Latinx STEM graduates accepted the invitation to share their perhaps previously untold stories and to relate personal backgrounds, histories, struggles and triumphs in fields where few representative of their ethnic background had gone before. The value of

testimonio as a methodological tool is that it offers nuanced understandings of complex, layered lives; allows for individual expression that is likely to be a collective experience; reveals institutional and structural inequalities that preclude success; and allows individuals to visibly share their personal voice to articulate the truth of their experience (Latina Feminist Group, 2001). Knowledge gleaned from *cientificos* Latinxs thus became rooted in the participants' own expressed life stories, and not on assumptions about individual achievement rooted primarily in privileged student experiences.

Researchers analyzed each *testimonio* to uncover prevalent themes. All 14 essays were analyzed, coded and organized to discern key themes. Each key theme was the result of at least seven different STEM graduates' comments that collectively clustered to produce a major theme. To ensure trustworthiness and validity of data, member checking was conducted. A draft of the entire knowledge essay was sent to a sample of study participants (N=4) who agreed to review the knowledge essay. Participants were asked to review the knowledge essay to discern whether the report accurately captured the student story, to determine if the researchers were missing any important information that could inform the study and to make any recommendations to improve the report.

Counter-Story Telling

We employed counter-storytelling as an analytical framework to reframe the dominant, racialized stock story about Latinx student educational achievement based on longstanding, and ongoing, deficit narratives. Among these racialized views is that Asians and Whites, especially White men, are "good in STEM," but that Latinxs and African American students, especially women, are not. These racialized biases and the facing of negative stereotypes about one's social group can create a psychological barrier known as stereotype threat (Steele & Aronson, 1995).

For example, when students fear they are being judged stereotypically as academically incompetent, this can lead them to perform poorly (Education Trust-West, 2017; Raynor-French, 2017). Solorzano and Yosso (2002) define a counter-story “as a method of telling stories of those people whose experiences are not often told (i.e., those on the margins of society). The counter-story is also a tool for exposing, analyzing, and challenging majoritarian stories of racial privilege. Counter-stories can shatter complacency, challenge the dominant discourse on race, and further the struggle for racial reform (p 32).”

One of the racialized, dominant stories about Latinxs is that they are not math and science material because they are incompetent and lack the determination needed to succeed in STEM. Yet this deficit-minded narrative does not hold up when examined through the lens of Latinxs who are successful in STEM or from the stories of people who have faced adversities and still managed to become successful in life (Jay, 2017). The examples below illustrate this point.

In the early 1980s Garfield High School math teacher, Jaime Escalante, a Bolivian immigrant, was teaching students who some deemed to be “unteachable” in East Los Angeles. Escalante’s story, featured in the 1988 film, *Stand and Deliver*, chronicles his role in successfully turning Mexican American students from low-income communities into highly-capable mathematics achievers. Instead of viewing students as remedial learners, he boldly taught them calculus. In 1982 Escalante was the subject of national controversy because 18 of his students passed the challenging Advanced Placement Calculus exam, and the Educational Testing Service challenged the scores. The organization was proven wrong when every student who retook the test passed a second time. A similar true story is told in the movie, *Spare Parts*, where the sons of undocumented Mexican immigrants learned how to build an underwater robot from Home Depot parts. Their robot was so functional and well built, it defeated the robot built by students

attending the Massachusetts Institute of Technology (Rendón & Kanagala, 2017; Davis, 2014).

The film, *Hidden Figures*, makes visible what had been obscured from the American public—that a tenacious, intellectually gifted group of African American women was behind the mathematical calculations that allowed space heroes like John Glenn to travel safely into space.

The fact that our society is in disbelief with stories highlighting that low-income students of color can and do perform well in STEM is very telling. Quite simply, some refuse to believe that anything good can come out of what are perceived to be second-class people of color. Yet scholars have underscored that, regardless of poverty status, Latinxs and underserved students are able to succeed in their own way. Regrettably, their counter-stories are not fully captured in the dominant narrative about what constitutes student achievement. As Solorzano and Yosso (2002) point out, majoritarian perspectives rely on stock stereotypes, emphasizing that all related to people of color and poverty must be “no good,” while all connected to white, affluent people is not only superior but also quite natural (Delgado Bernal, 1998).

Informed by critical race theory, counter-stories are a part of critical race methodology. These stories are valuable in the sense that they put a human face to the real-life experiences of marginalized groups. Further, the counter-narrative can employ race as a filter to examine dominant stories, expose and challenge majoritarian stories of racial privilege, and make visible assumptions made by the dominant culture. Importantly, counter-stories disrupt the notion that the world can be viewed only in the way that privileges the dominant majority culture, and they can be employed to challenge racism, sexism, heteronormativity and classism in an effort to work toward social justice (Solorzano & Yosso, 2002). The counter-story can benefit from maintaining theoretical sensitivity (Delgado Bernal, 1998; Strauss & Corbin, 1990) where the researcher is aware of the subtleties of the data, has insight and understanding, and has the ability

to give meaning and to assign pertinence to the data. A counter-story is also enhanced with cultural intuition (Delgado Bernal, 1998) that “extends one’s personal experience to include collective experience and community memory, and points to the importance of participants’ engaging in the analysis of data” (pp. 563-564).

Study Sample of Latinx STEM Graduates

Table 2 portrays the characteristics of the study sample. Most of the participants had a Mexican American heritage (N=10), while the heritage affiliation for the remaining four participants included El Salvador, Mexico, Puerto Rico and the Dominican Republic. While eight met the criterion for first-generation college students whose parents had not attended college, some students had parents who had earned undergraduate or graduate degrees in another country. These students could still identify as first-generation college students because their experiences were similar to those born in the U.S.—lack of knowledge about the higher education system, difficulties accessing financial support, experience of cultural shock, family responsibilities, etc. Due to these nuances, coupled with the fact that Latinxs are underrepresented in STEM, all of the study participants were categorized as Latinx underserved STEM students.

TABLE 2. LATINX STEM GRADUATES’ CHARACTERISTICS

STEM Graduate Name/Gender	Gender	Last Degree Earned	Key Fields of Study	Professional Titles Held
Stephany Alvarez-Ventura	Female	M.S.	Agroecology, Environmental Studies	Program Manager, School of Environment, Arts and Society, FIU
Xiomara Elias Argote	Female	M.S.	Biochemistry, Microbiology, Biotechnology	Quality Compliance Manager, Food Science Industry
Alejandro Ariaza	Male	M.S.	Mathematics, Higher Education Administration	STEM Advisor, Northwest Lakeview College
Diana Del Angel	Female	M.S.	Environmental Studies	Gulf Research Program Science Policy Fellow, National Academies of Sciences, Engineering and Medicine

Julissa Del Bosque	Female	B.S.	Biology	Undergraduate Student, UT-Austin
Dana M. Garcia	Female	Ph.D.	Zoology, Physiology	Chair of Biology, Texas State University, San Marcos, TX
Karla Gutierrez	Female	M.S.	Industrial Engineering	Research Associate & Doctoral Candidate, UTEP
Rodolfo Jimenez	Male	Ph.D.	Cellular & Molecular Biology, Biochemistry	STEM Coordinator & Data Analyst, UT-Austin
Ricardo Martinez	Male	M.S.	Mathematics, Curriculum & Instructional Technology and Mathematics Education	Doctoral Student, Iowa State University
Olivia Moreno	Female	M.S.	Environmental Science & Engineering, Industrial Engineering	Doctoral Candidate in ES & Engineering; Program Specialist, US Dept. of Agriculture-Institute of Bioenergy, Climate & Environment
Elvia Elisa Niebla	Female	Ph.D.	Soil Chemistry	Former National Coordinator for Global Change Research at the Forest Service – USDA
Semaryh Quinones-Soto	Female	Ph.D.	Microbiology	Biology Lecturer & Academic Advisor
Marina B. Suarez	Female	Ph.D.	Geology, Geosciences	Associate Professor, UTSA
Simon Trevino	Male	Ph.D.	Biological & biomedical Sciences	Postdoctoral Scientist II, Texas Biomedical Research Institute, San Antonio, TX

The Journey to A STEM Degree: Challenges Experienced

In her book, *Supernormal*, Meg Jay (2017) indicates that by age 20 nearly 75 percent of people experience some form of adversity. Contrary to the popular dominant narrative that major adversities preclude success, Jay provides evidence that everyday people can triumph over adversity and rise up even stronger than before. The path to a STEM degree was not easy. Even early in life, STEM students faced significant obstacles which could have easily stopped them from undertaking scientific study.

Critical Challenges

The most critical challenges faced by Latinx STEM graduates were related to dealing with life adversities, experiencing academic-related challenges, living with limited resources, attending to family responsibilities and experiencing gender-related issues—see Table 3.

TABLE 3. CHALLENGES EXPERIENCED

Challenges	STEM Graduates' Comments
<p>Life Adversities</p> <ul style="list-style-type: none"> ● Health-Related Issues 	<p>Initially I saw the team doctor at his office where he took an EKG. He saw there was a bit of an abnormality in the results, so he scheduled an appointment for me with a cardiologist for the next day. At this point I wasn't sure what to think as I never thought I would be seeing a cardiologist at the age of 16. Walking into the office of the cardiologist was a bit shocking to me since there didn't seem to be anyone under the age of 70 there. The doctor examined my initial tests from the team doctor and told me he would do another EKG as well as an echocardiogram. After the tests were done and he reviewed them, he came into the room and said I had a heart murmur and needed to be checked into a hospital immediately. <i>(Rodolfo Jimenez, p.166)</i></p>
<ul style="list-style-type: none"> ● Death in Family 	<p>My little sister, Elisa, was close to home when the accident occurred, but it still happened. It was my dream to become a scientist and professor, so I know even though part of her, and part of me, was ready to call it quits and move home, I know I had started this, and I wouldn't forgive myself if I quit. I'm pretty sure my little sister wouldn't want me to quit either. <i>(Marina B. Suarez, p. 192).</i></p>
<ul style="list-style-type: none"> ● Leaving Native Country 	<p>For me, my sacrifice was missing out on family events. A few years into my graduate program, during our weekly phone call, my grandfather reassured me my family was accepting of the sacrifices I had to make when he said, "Don't worry about us, we are doing just fine. You keep working hard and do what you were meant to do." That was the last time I spoke to my grandfather. Later that week, he had a seizure and hit his head on the corner of the table. The blow he suffered caused him to pass a month later. This was most certainly one of the most challenging times, not just in graduate school, but my life. <i>(Rodolfo Jimenez, p.171)</i></p> <p>My grandfather had a weak heart, and all the civil problems aggravated his condition. Our economic status did not permit</p>

<ul style="list-style-type: none"> ● Time Management ● Academic Culture Shock 	<p>That first year of college was the most challenging for me since I had to struggle with time management. <i>(Olivia Moreno, p.179)</i></p> <p>During my first year at Bowdoin College, I struggled to maintain the appropriate grade point average to pass my classes and ultimately failed...I finally decided it was in my best interest to go home and transfer back to a community college. Having to start over with my educational journey was a difficult pill to swallow. <i>(Alejandro Ariaza, p. 136.)</i></p> <p>One of the first roadblocks I hit as a Chicano in science was my own learned insecurity...I simply hadn't grown up around professors and scientists—there was no immediate way to feel comfortable around people I didn't know much about. The blunt, critical academic way was also new to me. I was raised to defer to adults, not to ask too many questions, and to be overly polite. <i>(Simon Trevino, p. 197)</i></p>
<p>Living with Limited Resources</p>	<p>My mother worked in the fields, mostly picking grapes. Growing up, my family was poor. We lived in six different houses, and this was normal for many families in my community. My father left my mother before I was born, and still to this day, I only remember talking to him once. <i>(Ricardo Martinez, p 174).</i></p> <p>I knew I wanted to go to college because I saw the many hardships that my parents went through while we were growing up working two jobs sometimes and as a result we would not see them often because they worked so much. <i>(Olivia Moreno, p.178)</i></p> <p>My parents always made sure I never worried about finances. I was constantly reminded to find a school where I would be proud of going and embrace every aspect it had to offer. Lastly, my parents always said, “Do not let the price of tuition scare you. If you want to go there, we will find a way.” Hearing that put more pressure on me. I knew my surgeries had put a burden on my parents, so how could I even imagine committing to a four-year university? <i>(Julissa Del Bosque, p. 147)</i></p>
<p>Family Responsibilities</p> <ul style="list-style-type: none"> ● Sibling care 	<p>My parents had to work very hard to pay for my college fees, so I was responsible for my little sister and became a mother figure to her. I also worked part time at the community college to help with the fees. <i>(Xiomara Argote, p.153)</i></p>

<ul style="list-style-type: none"> Financial contribution to family 	<p>As soon as I graduated, my first thought was to find a job and pay off my loans as well as to help my family with the expenses. I also wanted to help my little brother with his college tuition because he was going to start college soon. <i>(Karla Gutierrez, p. 161)</i></p>
<p>Gender-Related Issues</p>	<p>I would love to see more women in the Science Technology and Engineering Fields. Every time I would go to one of my engineering classes at the university, I would notice that the majority of the students enrolled in the classes were male. Also, I have noticed that not a lot of females take the route of teaching Science Technology Engineering and Mathematics (STEM) courses. It is important to encourage our equals to pursue this discipline. We need the female side to be part of this isolated field along with the Latina side. <i>(Karla Gutierrez, p.162)</i></p> <p>In all my college career, I was usually the only person of color or one of no more than two or three females in science classes. <i>(Elvia Elisa Niebla, p. 182)</i></p>

Keys to Success: High-Impact STEM Practices

The research literature has identified a number of high-impact pedagogic practices (Kuh, 2008; Rendón, 2009) that have been effective with college and university students. Among these HIPs are experiential, hands-on learning, deep learning experiences, validating experiences, study groups, internships, learning communities, service learning, capstone courses, study abroad and research with a faculty member. Table 4 portrays STEM HIPs that Latinx STEM graduates mentioned were particularly helpful to them.

TABLE 4. HIGH-IMPACT STEM PRACTICES

STEM HIPs	STEM Graduates' Comments
<p>Experiential Learning</p>	<p>Upon completing my units, I then transferred to California Polytechnic State University (Cal Poly) in San Luis Obispo to pursue a degree in Biochemistry. I was not aware of the ranking of this school but later found out that their program was in a high demand due to their “hands-on” teaching style, which helps to process information easier and gets students exposed to current problems that can be solved with science, technology, and to the work field. <i>(Xiomara Argote, p.153)</i></p>

	<p>Although I found ...courses exciting, they were not helping me make a decision between ...two [fields]. My professors suggested that I get hands-on experience with undergraduate research. Undergraduate research would allow me to use what I learned in the classroom and determine how well I fit in a science field. <i>(Semarhy Quinones-Soto, p. 185)</i></p>
<p>Internships – U.S. Based & International</p>	<p>A semester before finishing my graduate degree my advisor asked if I wanted to complete a summer internship in Washington, DC with...USDA. Today I can say that this is my fourth summer interning...They will convert me into a full-time government employee. All the training and experience I have been exposed to these summers have been one of the most rewarding steps toward my STEM career. <i>(Olivia Moreno, p.179)</i></p> <p>Another piece of advice I would give students is to try to get a summer internship while you are an undergraduate. This gives you some valuable experience. For me, this proved vital. I had two internships while I was an undergrad, one with the National Park Service at Badlands National Park and one with the Bureau of Land Management. During my internship at Badlands National Park, I met the person who would be my next great mentor ...from Temple University in Philadelphia. ...Both I and my twin sister were able to get teaching assistantships at Temple. <i>(Marina B. Suarez, p. 191)</i></p> <p>As an undergraduate, I also got to do a summer internship at Harvard...In the span of something like 10 weeks, I learned a new topic, new skills, and expanded my network <i>(Simon Trevino, p. 194)</i></p> <p>I started Cal Poly in 2001 and later found an advertisement to do an internship abroad with a full scholarship. I got very excited and put my application together, which ended up being a microbiology internship in Mallorca, Spain, for the summer of 2002. This opened the doors to the world of research. <i>(Xiomara Elias Argote, p. 153)</i></p>
<p>Undergraduate Research with Faculty</p>	<p>I started doing research in {professor's} lab. It was my first exposure to actual scientific research and I was hooked...From this point on, I was always involved in independent research. I even joined {professor's} lab the following year in a collaborative project. <i>(Rodolfo Jimenez, p.169)</i></p> <p>One of the options in the honor's program at Texas A&M was to write an honor's thesis based on undergraduate research. My roommate suggested that I should approach {professor} about the possibility of doing research in her lab. I met with her, and she</p>

	<p>accepted me into her laboratory, despite the fact that I kept dosing off during my interview... One thing stuck with me: In science, 90 percent of your experiments will fail. She was letting me know that success in science requires perseverance and resilience. (<i>Dana M. Garcia, p. 157</i>)</p>
Faculty Mentoring & Advising	<p>I am deeply grateful for Dr. Heise's guidance. As a first-generation science student and first-generation college student, I was extremely lost. I had no idea where to find scholarships, internships, or what graduate school would entail. (<i>Diana Del Angel, p. 141</i>)</p> <p>It was while at {the University of Kansas} that I met the persons who would be my next advisers, mentors and friends. Dr. Luis Gonzalez ran the stable isotope lab at Kansas, and if I were to come to Kansas, I would be working under an NSF grant that he and his colleague (Dr. Gregory Ludvigson, who would be my co-adviser) were awarded to better quantify the climate in the Cretaceous Period... I brought some samples I had collected from Utah that were a part of my master's research. Luis stayed up late one night with me working on the samples by analyzing them... It was this experience that convinced me to go to Kansas. If someone were going to go to those lengths to help someone who wasn't a student, I knew this person would have my best interests as a student. (<i>Marina B Suarez, p. 192-3</i>)</p> <p>My mentor had graduated many students before and laid a very important, basic understanding of what science is and how, while I may never do it perfectly, I could, on a string of good days, do it well. In addition to introducing me to the framework of science, he introduced me to a lot of other people who lent their own ideas about science and the industry of academic science and how they got to their career levels. This kind of encouragement is really important no matter what you find yourself doing in life (<i>Simon Trevino, p. 197</i>)</p>

Keys to Success: Financial Support

Latinx students benefitted from financial assistance to continue their education. Table 5 provides a list of financial bases of support that assisted students.

TABLE 5. FINANCIAL SUPPORT

Financial Support	STEM Graduates' Comments
Funding for Minority Scientists	I was fortunate to be well funded, thanks in part to programs developed at the National Science

	<p>Foundation that were designed to help minority scientists get started and to help primarily undergraduate institutions develop research programs. (<i>Dana Garcia, p.158</i>)</p> <p>If you demonstrate an interest in science, you might be able to get sponsored by programs such as Minority Biomedical Research Support (MBRS)...designed to help transition undergrads into scientific research. (<i>Simon Trevino, p. 196</i>).</p> <p>In 2000, I applied for a National Institutes of Health—Minorities Access to Research Careers (NIH-MARC) fellowship program. Since I had very good grades and excellent letters of recommendation from my professors, I was awarded two years’ funding to work as an NIH-MARC undergraduate researcher on campus. (<i>Semarhy Quinones-Soto, p. 186</i>)</p>
NSF Graduate Fellowships	<p>I was awarded a National Science Foundation Graduate Fellowship, which allowed me to choose a graduate school without being so concerned about how I would finance myself. This was good news because I had thought that graduate school was going to be very expensive, and I had been following my own austerity program in which I only buy food that cost less than \$1 per pound, and turned off the AC, heater and water heater in my apartment. (<i>Dana Garcia, p.157</i>)</p>
Family support	<p>My family was the main financial support, but I also applied to any scholarship that was available for international students. (<i>Xiomara Argote, p.153</i>)</p>
University Scholarships and Graduate Student Support	<p>I was blessed with a scholarship that paid for my associate degree, and my whole mind-set of only getting my basics was out of the picture. When I saw that email in my inbox, I knew Northwest Vista College in San Antonio, Texas, would be my home for the next two years. (<i>Julissa Del Bosque, p. 147</i>)</p> <p>I did not know that for many majors when you attempt to get a PhD the school pays you to study and work. Right now, my doctoral education is being paid for by Iowa State University, and the university pays</p>

National Merit Scholarships	<p>me money every month to work 20 hours a week. (Ricardo Martinez, p 176)</p> <p>I decided to attend Texas A&M University in College Station, where I started out as a pre-med student. Texas A&M had aggressively recruited me to come to their school by offering me a President’s Endowed Scholarship and a National Merit Scholarship, which together pretty well paid all my college expenses. (Dana Garcia, p, 156)</p>
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Keys to Success: Validation from Significant Others

Both in and out of college, study participants benefitted from a collective web of support from a diverse network of validating agents (i.e., parents, school teachers, college faculty, mentors, advisers and guidance counselors). This validation from significant others served to provide academic validation (Rendón, 1994) in the form of academic skill development, as well as guidance and exposure to STEM fields. Validating agents also served as mentors and role models that students could aspire to emulate (Nora & Crisp, 2007). Students also benefitted from interpersonal validation (Rendón, 1994) in the form of role modeling, encouragement, inspiration, and support.

TABLE 6. VALIDATION FROM SIGNIFICANT OTHERS

Validation from Significant Others	STEM Graduates’ Comments
Validation from Family	<p>My parents instilled in me a sense of obligation to make the most of my God-given talents to serve society as best I could. (Dana Garcia, p.156)</p> <p>My dad was, and still is, my inspiration. He is an Electrical Engineer, and he did graduate from UTEP, and because of him and all of his hard work, I have always wanted to be an engineer. He always had interesting work and experiences to share. He always had a challenge that he somehow managed to resolve. Still now, after so many years of manufacturing related jobs, he talks about his work with so much</p>

	<p>passion that it gets you involved in the talk. (<i>Karla Gutierrez, p.160</i>)</p>
<p>Validation from Early School Teachers</p>	<p>My teachers, however, played an important role in my development and influenced my life. One of them was my 4th grade teacher, Señorita Fatima, who was caring and friendly, which was just what a kid needed after a difficult time. I started to participate in math, grammar, and contests. (<i>Xiomara Argote, p.152</i>)</p> <p>I was blessed with good teachers and was well prepared for college through my public-school experience with a sound foundation in English, math (although I slacked some there in that I opted out of taking high school calculus) and science. (<i>Dana Garcia, p.156</i>)</p>
<p>Validation from Professor/Adviser/Mentor</p>	<p>So I finished my Bachelor’s in Industrial Engineering in 2009 and during that last semester I met my professor that was eventually going to be my advisor for my master’s thesis and doctoral dissertation. She was not my favorite teacher because she was very demanding with homework and assignments; her exams and quizzes were very challenging, and she was not very lenient when it came to grading. Now that I look back and reflect on how hard she was, I can honestly say that I appreciate her being like that because it made me try harder and be the successful woman I am today. (<i>Olivia Moreno, p.179</i>)</p> <p>My mentor, Dr. Dawe, also helped to reassure me I had made the right decision in going to UGA for the summer when he told me, “You have what it takes to be a scientist.” It was at that moment when I had no doubt that I would be getting my PhD. (<i>Rodolfo Jimenez, p.170</i>)</p> <p>Dr. McKenzie was a very young professor and his enthusiasm for physiology was contagious. I wanted to be just like him. (<i>Dana Garcia, p.156</i>)</p> <p>My second inspiration has been my advisor, counselor, and academic guidance counselor Dr. Heidi Taboada. She is the reason I’m almost done with my Ph. D. today. She has always encouraged her students to learn about new things and to challenge themselves. (<i>Karla Gutierrez, p.160</i>)</p>

Keys to Success: Student Assets/*Ventajas y Conocimientos*

While there is general agreement that succeeding in STEM requires students to develop academic-related competencies such as written and oral communication, problem solving, and critical thinking, what is often overlooked are specific *ventajas* (assets) and *conocimientos* (funds of knowledge) of Latinx STEM students (Moll, Amanti, Neff & Gonzalez, 2001; Rendón, Nora & Kanagala, 2014). Strengths rooted in the Latinx culture have not received extensive research attention signifying a glaring void in the literature that precludes a full understanding of Latinx life experiences and trajectories toward success in STEM. Below we elaborate on four *ventajas y conocimientos* specific to STEM students: 1) giving back, 2) curiosity, 3) *ganancias*/perseverance and 4) navigational.

Giving Back

In a study of Native college graduates, Nicole Salis Reyes (2016) examined the concept of “giving back,” the notion that individuals look beyond personal gain to consider how they might put their gained academic tools back into their communities. For many marginalized student populations, earning a college credential means more than having a degree to hang on a wall; it carries a higher meaning as students begin to perceive themselves as role models who reach out to assist others and to help their communities survive (Rendón, Nora & Kanagala, 2014). Giving back is an essential component of Native students’ ways of knowing that appears to be a critical factor that propels them to excel in higher education.

Similar to Native students, Latinx STEM graduates exhibited a sense of spiritual nobility rooted in their belief system that a college degree signified a higher calling. They spoke affirmatively about their desire to use their talents to be of service to their beloved Latinx community, as well as the larger society. They also wanted to address inequities and the

underrepresentation of Latinx students and professionals in STEM. Table 7 depicts the significant asset of giving back.

TABLE 7. ASSET: GIVING BACK

Forms of Giving Back	STEM Graduates' Comments
<p>Service to Latinx Community and Greater Society</p>	<p>Freedom is written with blood, and work is written with sweat. This was the motto I heard throughout my childhood but did not understand it completely until years later. Nevertheless, it guided me toward a career in science because I wanted to help others and alleviate suffering among my people. (<i>Xiomara Argote, p. 150</i>)</p> <p>Knowing that I am serving my government and serving the people of this country is very gratifying. I feel empowered that I am using my expertise to get a role in processing government funds to better serve and educate our Latino communities. The range of funded research from USDA ranges from determining how to provide healthier school lunches for kids to defining how to make cleaner energy to leave a better planet for future generations. (<i>Olivia Moreno, p.179</i>)</p> <p>It was not until my final year as a math major that I realized I wanted to teach...I realized I enjoyed math tutoring and helping people more than working on math problems, so I made the change and became a high school math teacher because I wanted to help students the way my algebra teacher changed my life. (<i>Ricardo Martinez, p. 176</i>)</p> <p>I hope to improve environmental conditions and coastal conservation through the use of science and advocacy. (<i>Diana del Angel, p. 144</i>)</p> <p>For me, global change, including climate change, is the biggest threat to the planet, and working in this field at the national and international levels has made my life's work worthwhile. In fact, the most rewarding aspect of my work has been knowing that I contributed to the progress of humankind, improving the environment and promoting significant research in the field. (<i>Elvia Elisa Niebla, p. 183</i>)</p>

<p>Address Inequities and Underrepresentation of Latinxs in STEM</p>	<p>The underrepresentation of minorities in STEM fields leads to a bigger picture. Without minority STEM male and female influences, our job outlook is dim... Each time I advise a new student about a STEM-related field, I remind them that they are a huge asset to this city, state, and most importantly, the world. (<i>Alejandro Araiza, p.138</i>)</p> <p>Science is a deeply creative pursuit. The more cultural diversity we have in the laboratory, the more ways we have at viewing and tackling problems (<i>Simon Trevino, p. 195</i>)</p> <p>With my research, I am establishing my own theory of how people learn to make math more equitable. The work I do will help train future math teachers how to incorporate the rich cultural knowledge of their students...As a Latino I am proud to contribute to the rich STEM history that is associated with the Latinx culture—from all the great pyramids built in Mexico and Latin America to the science behind sun dials and powerful problem solvers. (<i>Ricardo Martinez, p.174</i>)</p> <p>I wish to encourage students who have been silenced due to lack of knowledge of the importance of educational equity necessary for the reinvestment of this economy. (<i>Alejandro Araiza, p. 137.</i>)</p> <p>We as Latinxs have so many different backgrounds, cultures, and ways to do things that can be helpful in solving problems, whether it is designing the car of the future or finding emission-free combustibles. The idea of a multi-cultural, or diverse, STEM field should complement our ideas and experiences to make our world a better place to live in, and make our life easier... We need more Latinos and Latinas that are interested in the fields of Science and Engineering so that we can help make a better future. (<i>Karla Gutierrez, p.162</i>)</p>
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Curiosity

Sometimes, even at an early age, curiosity and the associated sense of wonder and discovery appeared to account for students’ interest in STEM (See Table 9).

TABLE 8. ASSET: CURIOSITY

Forms of Curiosity	STEM Graduates' Comments
Sense of Wonder	<p>If I had to summarize my life journey...I would say it was fueled by a need to know. Even as a young girl, I always wanted to know what happens when you put a snail, a grasshopper, and a fuzzy worm in the same jar? Curiosity can get you stung by insects or punished by your abuela, but curiosity can also reroute your career life. (<i>Diana del Angel, p. 139</i>)</p> <p>As a young girl, I looked at the sky and wondered what made up clouds? Where did they come from? I was in awe to see that huge watermelons grew from tiny seeds my father planted in our yard. How could that be? I was full of questions, and as I grew older, it seemed to me that science had the answers to my questions (<i>Elvia Elisa Niebla, p. 180</i>).</p> <p>That curiosity continued on to when I started school. I wasn't just interested in learning what was taught, I wanted to go into further detail as to why it was that way. Between the ages of 5 and 10, I was definitely the "why" child of my family. Most of the time my family understood it was because I was actually curious and not trying to be annoying. But, trust me, there were plenty of times they wished I would stop asking why. (<i>Rodolfo Jimenez, p.164</i>)</p> <p>My body and mind always jittered with energy, moving too fast for teachers, I didn't understand. I always entered a different realm, where daydreams fostered creativity. (<i>Stephany Alvarez-Ventura, p. 131</i>)</p>
Sense of Discovery	<p>As you can imagine, it was extensive work but the sense of discovery and learning new things every day, was so encouraging. (<i>Karla Gutierrez, p.161</i>)</p> <p>It had been my dream since I was a kid...to find a dinosaur...to be the first person to lay eyes on something that lived millions of years ago...It turns out the site [we visited] had many bones...One of them was named for my twin sister and me: <i>Geminiraptor suarezarum</i>. (<i>Marina Suarez, p.192</i>)</p>

	<p>So my forms of entertainment were either playing outside or watching PBS. This lack of television entertainment helped me to develop my curiosity for how things worked. This curiosity developed from watching a show on PBS called “Newton’s Apple.” The curiosity developed from watching this show led me to explore what I was surrounded by at my grandparent’s house. I was constantly digging up the dirt and wondering what it was made of, mixing certain liquids together to see what the mixture would make, and also trying to see what I could create from loose materials around my grandfather’s garage. Luckily, any mixture I created never caused me, or anything around me, any harm. (<i>Rodolfo Jimenez, p.164</i>)</p> <p>What makes all of these islands different? Will my South Padre Island look like Galveston in the future? What will happen if sea level continues to rise? Why are dunes very large in certain sections of a beach and not in others? I did not have answers to any of these things. If I could continue to a graduate degree, these were the things I wanted to find out. (<i>Diana Del Angel, p.140</i>)</p>
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Ganas/Perseverance

In their study of what accounts for the academic success of Latinx students, Rendón, Nora and Kanagala (2014) discovered that *ganas/perseverance* was a *ventaja* (asset) that was connected to students’ resilience and drive. The researchers noted that: “Underlying this *ventaja* is determination, self-reliance and inner confidence. Admirably, students were refusing to quit, and they also recognized and embraced the sacrifice that must be made in going to college. Overall, the life experiences and circumstances of students paint a picture of hardships and adversities that one would think they would not be able to overcome, but they did” (p. 18). Table 9 provides examples of students’ courage, determination and resilience.

TABLE 9. ASSET: GANAS/PERSEVERANCE

Forms of Perseverance	STEM Graduates' Comments
Courage/Determination	<p>The death of my father (grandpa) and the difficult times motivated me to keep going. You can either tell yourself, “No puedo,” or you can become that person that everyone says, “No se como lo haces.” I chose the latter. (<i>Stephany Alvarez-Ventura, p. 133</i>)</p> <p>Latinx people have innovation, courage, and determination to get things done, which can make a positive impact on this country. Immigration status may diminish us from getting any further, but we have the heart to fight and accomplish our goals. Latin kids have the mind to explore and the will to accomplish goals, and this is what is needed to be successful in science, technology, engineering, or mathematics. (<i>Xiomara Argote, p.155</i>)</p>
Resilience	<p>Graduate school was not easy...A big part of pursuing a doctorate degree is to work full-time as researchers on an independent project directed to write a thesis at the end of your graduate education. I had numerous failed experiments, which made me question my career choice every day, but no matter how bad things were, I always said to myself “just give it one more day.” This was my motto until my last day as a graduate student. (<i>Semarhy Quinones Soto, p. 188</i>).</p> <p>As I checked into the hospital later that day, I told myself I would not let this hold me back from doing whatever I was put on this earth to do. The doctor ran multiple tests to see if he could pinpoint why I had this irregular heartbeat. But he was never able to come up with a solid reason. So he gave me some medication and told me he would monitor me for six months. Glad to be alive, I was constantly asking why did this happen to me? Would I be able to live a normal life? For the time being, it limited me only in sports. The time off from sports allowed me to reflect on what it meant to be alive and what I wanted to do with my life. This scare cemented that I would not let anything stop me from going to college and pursuing a career as a physical therapist. (<i>Rodolfo Jimenez, p. 166</i>)</p>

Navigational

Study participants showed a remarkable ability to navigate through many transitions in their lives. These twists, turns and stalls included changing majors or programs of study, transitioning from another nation and learning a new culture—see Table 10.

TABLE 10. ASSET: NAVIGATIONAL

Navigational Types	STEM Graduates' Comments
<p>Changing Major or Program of Study</p>	<p>My current career is different than the one I originally dreamed about. I currently work in the food science industry as a Quality Compliance Manager where I apply my background. I did not become a doctor, but I do use my knowledge to help other people that require assistance in science, especially to let Hispanic people know the consequences of antibiotic over usage. (<i>Xiomara Argote, p. 154</i>)</p> <p>I had hopes of becoming an analytical chemist as I was intrigued with the process of analyzing various substances. However, as a graduate assistant, I began working in soil chemistry and found my passion. It was clear that the field was much more relevant to solving issues related to the environment. (<i>Elvia Elisa Niebla, p. 181</i>)</p> <p>When I got to Berkeley, I learned that the Physiology program was actually being discontinued. The eight or so students admitted to the program would be the second to the last class. The reason for its discontinuation was because at that time, physiology was seen as sort of passé or old school, and many programs were dropping it in favor of programs in molecular cell biology (MCB), on the one hand, and integrative biology on the other. That turn of events was fortunate for me because the new MCB program encouraged graduate students to test multiple labs before deciding where they would do their doctoral research. So, I spent my first rotation in Dr. John Forte's lab learning about how the stomach makes acid (and how his graduate students made coffee). Then, I moved to Dr. Beth Burnside's lab, and that is where I ended up staying. (<i>Dana Garcia, p.157</i>)</p>
<p>Transitioning from Another Nation/Learning A New Culture</p>	<p>When I graduated from high school, The Preparatoria El Chamizal in Juarez, we moved to El Paso. When we moved to the United States, I started the paperwork and the exams required to be enrolled in UTEP, which to be honest, was an exciting time but also a little scary. I was going to start school</p>

in a different city, and a different country. Even though we shared a lot of similarities, a huge difference would be the language. *(Karla Gutierrez, p.160)*

Keys to Success: Latinx-Centered Social and Academic Activities and Organizations

Latinx STEM graduates indicated that they had benefitted from participating in several Latinx-centered social and academic activities and organizations. These Latinx-centered spaces fostered social opportunities including support networks, peer mentoring, social skill development, and volunteerism. These networks, normally available to students whose parents are scientists and/or well-off financially, are critical to accessing opportunities such as getting internships and summer jobs that can change a student’s life trajectory and ultimate success in STEM. Further, these organizations provided academic-related programming that fostered leadership opportunities, professional development and career preparation—see Table 11.

TABLE 11. LATINX-CENTERED STEM SOCIAL AND ACADEMIC ACTIVITIES & ORGANIZATIONS

STEM Programs	STEM Graduates’ Comments
<p>Hispanic Ambassadors Program</p>	<p>I served on both the board of student mediators and was selected to participate in my school’s Hispanic Ambassadors Program, where I often found myself in the midst of tension between such groups. These opportunities helped me to develop social and mediation skills, as well as leadership. <i>(Stephany Alvarez-Ventura, p.131)</i></p> <p>There was no stopping me: I became a Student Ambassador, joined multiple honor societies (such as becoming President of Phi Theta Kappa and a member of National Society of Leadership and Success), became a peer mentor to help other incoming freshman to adjust to college life, started volunteering at Methodist Stone Oak Hospital. <i>(Julissa Del Bosque, p.148)</i></p>
<p>American Association for Hispanics in Higher Education</p>	<p>Networking and building a professional community of support is critical for aspiring Hispanic professionals. The American Association for Hispanics in Higher Education (AAHHE) is one such network that binds Hispanic professors and administrators to Ph.D. students and young professors. This group understands that Hispanic students starting college are</p>

	<p>entering a new world and often struggle to find guidance. They work to help build mentorship support between faculty and students so that you do not feel alone. Under a collaborative effort between AAHHE, Texas A&M University, and the U.S. Department of Agriculture (USDA), a Career Preparation Institute was launched with a National Thesis Competition. <i>(Stephany Alvarez-Ventura, p.134)</i></p>
<p>Society for Mexican American Engineers and Scientists</p>	<p>So as an undergraduate, I got involved with The Society for Mexican American Engineers and Scientists (MAES). Little did I know that as soon as I joined, I would be launched into a leadership role. <i>(Rodolfo Jimenez, p.169)</i></p>
<p>SHPE—Society of Hispanic Professional Engineers</p>	<p>Find internships, scholarships, grants etc. Get involved with clubs or societies in your chosen field. Professional societies often have various programs for students such as internships. This will allow you to meet other professionals from around the country and maybe around the world and help you begin your professional network. <i>(Marina Suarez, p.194)</i></p>
<p>Society for the Advancement of Chicanos and Native Americans in the Sciences</p>	<p>As a graduate student, I was introduced to the Society for the Advancement of Chicanos and Native Americans in the Sciences (SACNAS). As a member of SACNAS, I was able to gain great mentorship and life lessons specifically as it related to being a person of color in the sciences. <i>(Rodolfo Jimenez, p. 171)</i></p>
<p>Career Preparation Institute</p>	<p>Under a collaborative effort between AAHHE, Texas A&M University, and the U.S. Department of Agriculture (USDA), a Career Preparation Institute was launched with a national thesis competition. With an extra push from my adviser, Dr. Bhat, I submitted my thesis and earned the first-place prize. I also met with Dr. JoAnn Canales, the director for the program, and a great leader and advocate for mentorship to Hispanic students pursuing higher education. I had the opportunity to serve as co-chair and chair for the program, gaining insight to becoming a successful professional in a STEM field. <i>(Stephany Ventura, p. 134).</i></p>

Keys to Success: Latinx Family Cultural Pedagogics

Within the Latinx family unit, students benefitted from Latinx cultural pedagogics including *apoyo y cariño* (support and loving care), *ejemplos* (family academic and survival

modeling) and *trabajo* (ethic of hard work)—see Table 12. This form of Latinx cultural wealth is often overlooked but is in fact instrumental to student success in higher education. As families modeled habits of the mind and heart, students learned and developed the ethic of hard work, shaped their future views and personal habits, became inspired with the love and caring they felt from their family and developed the motivation to persevere and succeed. What Delgado-Bernal (2010) calls “pedagogies of the home” gave students a cultural knowledge foundation, as well as a means to stay strong, practice resistance and survive through hardships and disappointments.

TABLE 12. LATINX FAMILY CULTURAL PEDAGOGICS

Latinx Cultural Pedagogics	STEM Graduates’ Comments
<i>Apoyo y cariño/ Family Support</i>	<p>Experiences during the first few years of a person’s life can leave indelible marks. A good education, diet, and the environment, among other factors, can determine how successful a person may be in adulthood. If we take these aspects into consideration, then all the odds would have been against me, and I would not have had the opportunity to write this essay. But family support and the will to make a difference inspired me to keep fighting. (<i>Xiomara Argote, p.150</i>)</p> <p>...There was a sense of family in every stage of the educational pipeline. It was through this sense of cariño that I found my first job (<i>Alejandro Araiza, p. 136</i>)</p>
<i>Ejemplos/Family Modeling</i>	<p>My family strongly valued science and hoped that their children would pursue science-dependent careers such as medicine, engineering or dentistry. (<i>Dana Garcia, p. 156</i>)</p> <p>My mother has been the strongest motivator in my life. She was the first in the family to get a high school degree... I learned to refine my work and redo things over and over again until I would get them right, even for simple things like laundry. For sure, my socks were extra clean as she used to inspect carefully all the pieces I washed. Going back, simple acts like this shaped my views and habits at a very early age, which have been very useful in a science field where attention to detail and perseverance are highly appreciated. (<i>Xiomara Argote, p.151</i>)</p>

<p><i>Trabajo/Family Ethic of Hard Work</i></p>	<p>Obviously, my family, especially my mother and my aunts, influenced my life. Tia Chuly...was a strong, opinionated woman who held her own in political debates and who read to me from literary and political works. She was my role model. (<i>Elvia Elisa Niebla, p. 181</i>)</p> <p>My father loved exploring local marine life. From a very early age, he would take me snorkeling and taught me about the diverse and fragile marine ecology. Through my father, I gained my deep respect and appreciation for zoology and biodiversity. (<i>Semarhy Quinones-Soto, p.185</i>)</p> <p>When I visit Mathis, I cannot imagine my parents' lives and how they did the seemingly impossible...Their story inspired me to continue the tradition and go to college. I know my hardships and adversities are not nearly the same as my parents', but their struggle, their courage, and their successes are the foundation of who I am (<i>Julissa Del Bosque, p. 145</i>)</p> <p>By growing up in a single parent household, I saw my mother accomplish so much and demonstrate remarkable strength. Once she completed her bachelor's degree, my ambition grew, and I began to gain so much determination and desire to complete higher education. (<i>Alejandro Araiza, p. 136</i>)</p> <p>[My parents] grew up in the projects, and everyday my parents did not know where their next meal would come...Their story has a happy ending, and I am more than honored to say both of my parents are first-generation high school graduates and college students with bachelor's degrees...Their story inspired me to continue the tradition and go to college. (<i>Julissa Del Bosque, p.145</i>)</p> <p>Both of my parents only completed high school. As a result, I knew I wanted to go to college because I saw the many hardships that my parents went through while we were growing. Sometimes they worked two jobs and, as a result, would not see us very often. Although we did not see one another much, we always had food on the table. I remember how hard both of my parents worked so that my two brothers, my sister and I had new clothes, shoes and school supplies every school year. (<i>Olivia Moreno, p. 178</i>)</p> <p>Despite our poverty, we had great moments and learned to share and care for those who had even less. We had a small patch of land to cultivate corn, spinach, and other vegetables</p>
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	<p>that were sold at the local market. All of the grandchildren contributed from an early age in cleaning, cooking, harvesting, carrying water, doing laundry by hand, and in my case, to sewing as my mother was a seamstress. These early years taught me that hard work is the key to meet goals, and the results from such are the ones that bring satisfaction and pride to oneself. (<i>Xiomara Argote, p.151</i>)</p> <p>My grandparents knew that for their children, and their grandchildren, to have a better life they would have to move to the United States. In order to bring his family over to the states legally, my grandfather would cross the border illegally to work. Once my grandfather had enough money to pay for the immigration process, he brought the family to the States. With such a large family my grandparents wouldn't be able to provide for their family by themselves. So, once the children became old enough, they would join my grandparents and work in the fields. This way of life continued until all the children were out of high school, and some of the older siblings continued this way of life even after they had started their own families. (<i>Rodolfo Jimenez, p. 163</i>)</p> <p>My father worked every waking moment of the day yet felt hopeless that his master's degree in marketing was no match for my third-grade English reading homework. He would tell me stories of his own discipline in learning not for the love of it but to get out of trouble and challenge authority. My mother has always been there to remind me to take every opportunity presented and to fight hard in the face of adversity. (<i>Stephany Alvarez-Ventura, p. 131</i>)</p>
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Toward a New Counter-Story of Latinx STEM Success

In a classic publication of nine essays written by Latina scientists, *Flor y Ciencia: Chicanas in Science, Mathematics and Engineers* (Cantú, 2006), social psychologist Aída Hurtado provides a contemporary framing of the lessons gleaned from the *testimonios* (life narratives) of these extraordinary Chicana scientists who initiated a STEM career at a time when very few Latinas or women of color were participating in these fields of study.

Hurtado (2006) poses that a counter-story about student achievement is warranted. She notes that contrary to the master narrative that only individual perseverance and determination

can count as determinants of success, the Chicana scientists provided testimony that: “individual perseverance alone is not sufficient to succeed in male-dominated fields. Instead, what the stories uncover is a web of caring and support that propel these Chicanas into spheres previously uninhabited by people like them: predominantly working class, first generation in college, of color, and women. The ways in which they are embedded in the social relations that contributed to their success are much more complex and textured than individual explanations would lead us to believe” (p. 1).

The counter-narrative that Hurtado (2006) presented defies traditional wisdom about what constitutes success. Hurtado notes that Chicanas in science did not have privileged origins (rigorous early education, highly educated parents, and high income). Their education was not linear and was characterized by starts and stalls, twists and turns in their trajectories, financial and life challenges and lack of information about diverse fields of study. Regardless, they benefitted from a collective web of support from parents, extended family and community members. Their success was enhanced with relationship-centered, validating actions of teachers and mentors who provided encouragement, guidance and affirmation. A key lesson here is that what constitutes success for Latinxs in STEM must be grounded in their academic and social experiences that can reveal a complex, textured narrative that runs counter to what is traditionally said to account for high-level student achievement.

In her book, *Supernormal*, clinical psychologist Meg Jay (2017) draws on nearly two decades of work with clients and students to tell the story of supernormals among us, those who our society considers “resilient,” who somehow beat the odds and manage to bounce back from adversity. These include well-known celebrities, as well as men and women hiding in plain sight who are, for example, our doctors, scientists, professors, artists, activists and students. Jay notes

that resilience is not a trait that someone either has or does not have. Rather, resilience is a phenomenon, something seen but often not well understood. Further, Jay indicates that: “contrary to the notion that resilient youth bounce back from hard times, what they actually do is something more complicated and courageous. They are nothing if not protagonists in their own lives, often waging fierce and unrelenting battles others cannot see... theirs is a heroic, powerful, perilous lifelong journey, a phenomenon indeed—one that after decades of interest and research, still amazes and confounds” (p. 7-8).

Latinx student STEM success stories substantiate both Hurtado’s (2006) and Jay’s (2017) conclusions. The experiences of successful *científicos* Latinxs illuminate a courageous journey of triumphs and disappointments, one that most educators often neglect to see, yet alone comprehend or appreciate. Further, research has not fully explained their stories or accounted for how they succeeded despite facing formidable life adversities. The counter-story of Latinx STEM success shatters conventional thinking about the markers of student success, and illuminates new, culturally-sensitive perspectives and narratives of accomplishments and realizations. Several dominant narratives about student success were dispelled in this study:

1. Dominant Narrative: Individual effort is the sole path to STEM achievement.

Counter-Story: A collective network of validating agents is critical to provide

support, inspiration and encouragement which can facilitate success for Latinxs

in STEM. Contrary to the master narrative that only perseverance, determination and

individual hard work can propel students to succeed, what the study revealed was that

Latinxs did not succeed alone. Accordingly, Rendón’s (1994) theory of validation was

reinforced in this study. Students benefitted from a collective web of support from

their extended family, teachers, mentors, role models, advisers and counselors who

worked with an ethic of care and provided encouragement, inspiration, academic guidance, and exposure to STEM. As Jay (2017) notes, relationships are highly important in our lives. Jay cites study after study involving hundreds of individuals that reach the same conclusion: What protects individuals who face adversities from poor outcomes is feeling connected to significant others such parents, teachers, mentors, relatives, and loving partners. Jay underscores that “Part of the untold story of adversity and resilience then is that, for many, love is the greatest reboot of all” (p. 291).

2. Dominant Narrative: Life adversities typically result in life failure, especially for students of color.

Counter-Story: Despite significant hurdles and life challenges, Latinxs can succeed in STEM. One of the dominant narratives that was proven untrue is that low-income Latinxs (and by extension other underserved students) simply cannot succeed in STEM because their life circumstances are too overwhelming. As noted earlier, Jaime Escalante dealt with this racialized, deficit-based narrative years ago, and to some extent, the stock story remains entrenched almost to the point of being normalized. But what this study revealed is what both Hurtado (2006) and Jay (2017) confirmed: Resilient people can and do succeed despite formidable life challenges. Despite experiences such as poverty, transitioning to a new culture, racism, and lack of information about STEM fields, low-income Latinx STEM graduates succeeded in their own way. They succeeded by leveraging the academic, social, financial and cultural tools and opportunities they had before them. Figure 1 depicts how Latinx students were able to push forward and earn a coveted STEM degree.

3. Dominant Narrative: Latinx students and low-income communities are marked by acute social and academic deficiencies that render nearly all of Latinx students as incapable of doing STEM.

Counter-Story: Latinx students have a rich array of personal assets and Latinx families have their own cultural pedagogic practices which can foster academic success and survivance. Our analysis of Latinx STEM graduate *testimonios* confirmed Yosso's (2005) community cultural wealth model. Earlier in this essay we elaborated on four strengths specific to Latinx STEM students: giving back, curiosity, *ganas*/perseverance and navigational. Yet the stories also speak to assets related to their aspirations, the impact of the Latinx family, the students' ability to form social and academic networks and the ability to resist and overcome life challenges—see Table 13. These findings substantiate current research on Latinx student assets and ways of knowing (Rendón, Nora & Kanagala, 2014; Foxen, 2015; Cantú, 2006). Within their family culture, students also benefitted from Latinx cultural pedagogics such as *apoyo y carino/family support*, *ejemplos/family modeling* and *trabajo/family ethic of hard work* that Latinxs remembered even to this day as some of their most significant life experiences.

4. Entrenched Narrative: The most important way to attract Latinx students into STEM is to focus on jobs with big paychecks.

Counter-Story: For Latinx STEM students, earning a college degree is not all about the money. The STEM graduates featured in this study illustrate what other students of color have also indicated—that their primary focus in earning a college degree is a social justice orientation to STEM; that is, using their talents and expertise

to “give back” to the communities they come from, to advance humanity and to achieve equity in science fields. This included serving as role models and addressing social issues that impact health, climate, education and overall wellbeing (McGee & Bentley, 2017; Coleman & Ingram, 2015). These students had re-engineered their STEM degrees to align with a justice consciousness and with equity imperatives.

Table 13: LATINX STEM STUDENT *VENTAJAS* y *CONOCIMIENTOS*
VENTAJAS/ASSETS *CONOCIMIENTOS/FUNDS OF*

KNOWLEDGE	
Giving Back	<ul style="list-style-type: none"> ● Providing service to Latinx community and the greater society ● Address Inequities & underrepresentation of Latinx in STEM
Curiosity	<ul style="list-style-type: none"> ● Having sense of wonder and discovery
<i>Ganas</i> /Perseverance	<ul style="list-style-type: none"> ● Exhibiting determination, courage, resilience
Navigational	<ul style="list-style-type: none"> ● Able to navigate twists, turns and stalls including change of major, transitioning from another nation and learning new culture
Aspirational	<ul style="list-style-type: none"> ● Set goals to become scientist ● Understand sacrifice needed to be a scientist ● Stay focused and enthusiastic about future
Familial	<ul style="list-style-type: none"> ● Family validation, inspiration & support ● Latinx family cultural pedagogics—<i>apoyo y carino, trabajo, ejemplos</i>
Social	<ul style="list-style-type: none"> ● Participation in Latinx-centered social and academic activities and organizations ● Form support networks ● Peer mentoring ● Social skill development ● Volunteerism ● Leadership opportunities ● Professional and career preparation
Resistant	<ul style="list-style-type: none"> ● Ability to overcome poverty and life challenges ● Ability to resist racism and sexism

Recommendations

The following recommendations are offered to foster Latinx student access and success in STEM fields of study.

Recommendations That Address Access to STEM Education:

- FOCUS ON EARLY PREPARATION FOR STEM. There are highly-talented Latinx STEM students in the K-12 system who should be given the tools to thrive (i.e., tutors, mentors, exciting STEM projects, scholarships, special programs, school/family relationships).
- RE-MARKET STEM RECRUITMENT STRATEGIES. Market STEM not simply as a way to get a good job, but as a way to make a difference and to engage in addressing equity and justice issues such as climate change, water purification, virus control, and disease prevention, among others.
- AVOID RACIALIZED, DEFICIT VIEWS ABOUT LATINX STUDENTS AND COMMUNITIES. Despite adversities, Latinx students can succeed and should be aggressively recruited. This includes recruiting students from low-income communities.

Recommendations That Address Latinx STEM Success:

- RE-DESIGN BOTH STEM CURRICULA & PEDAGOGY. STEM course re-design should include attention to both curricula and to innovative, culturally-sensitive pedagogic practices. STEM faculty should engage students in reflective, deep learning experiences that leverage student assets such as giving back which is connected to equity and justice in STEM. Students want to learn content, but they also want to make a difference in their communities and in the

world. STEM projects could address social issues, for example, diabetes, water quality, cancer, obesity, mental health, climate change, declining infrastructures, and antibiotic resistant bacteria. Pedagogies that involve service learning and contemplative practices (Rendón, 2009) have potential to engage students in deep, reflective learning. Assisting STEM faculty to redesign STEM content and pedagogy will likely need to be a cooperative venture that connects STEM faculty, who have expertise in STEM, with College of Education faculty and staff, who understand pedagogy, advising and mentoring.

- **ADDRESS BOTH ACADEMIC AND PERSONAL DEVELOPMENT COMPETENCIES.** STEM faculty and staff should offer a well-rounded STEM education that includes an emphasis both on academic competencies (i.e., problem solving, critical thinking, content mastery) and non-academic skills and attributes (i.e., social networking and team building, navigational skills, social justice orientation, empathy, perseverance, resilience, and creativity).
- **PROVIDE PROFESSIONAL DEVELOPMENT FOR STEM FACULTY AND STAFF.** Faculty will need to attend conferences, workshops and retreats to learn to adapt high-impact STEM practices in their classrooms. There is also a need to focus on faculty and staff developing mentoring and advising skills and learning to work with low-income student populations. Faculty should also be given assistance to help students develop academic competencies such as making academic presentations, publishing and writing skills, and developing social competencies including networking opportunities, socializing with peers, attending conferences and taking trips abroad.

- FOSTER A VALIDATION-RICH CULTURE FOR LEARNING. STEM faculty and staff should be provided professional development opportunities to learn to create validation rich in- and out-of-class teaching, advising and mentoring environments. Positive, uplifting relationships are important in the sense that they provide affirmation, support and inspiration.
- WORK WITH AN ASSET-BASED FRAMEWORK. STEM faculty, counselors and advisers should move away from racialized, deficit-based views about Latinx students and focus on how to work effectively with students from underserved communities. Of importance is understanding the experiences and cultural strengths of low-income, first-generation students.
- CREATE STEM STUDENT SUCCESS CENTERS. Institutions should offer centralized hubs for STEM resources and a dedicated space for peer networking and creation of validating communities. In addition, these centers could provide skilled advising to assist students to select a specific STEM field of study, learn the impact of changing majors, engage in networking, and receive assistance when applying for financial aid and other types of financial awards.

Final Thoughts

In 2011 I completed my graduate degree after many years of hard work. The first calls I made the day I received my PhD degree were to my abuelas to whom I shouted: “Ya soy doctora.” Those were heavy words! They recapped all the tears, all my struggles in graduate school, and the time away from my family. They also meant I had achieved a lifetime goal, and I had made my family proud. (Semarhy Quinones Soto, p. 188)

The metastory of *cientificos* Latinx who accomplished what few of their cultural background have ever done before is a story of courage, resilience and spiritual nobility. Latinx STEM students survived and thrived in a world that is inconsistent with their cultural upbringing, and it is time for the STEM community of educators to rise to the challenge of making significant changes in the way they perceive Latinxs' potential to succeed in STEM. Call them resilient, supernormal or even super achievers, successful Latinx STEM students employed every traditional and cultural tool at their disposal to succeed in their own way. Lessons learned from their experiences have much to offer the world of STEM education, which can be better with more Latinxs and underserved students finding a genuine, viable presence in the ever-important scientific community.

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