Latinx Students in STEM Policy & Practice Brief

Realizing the PROMISE© of Success for Latinx STEM Students

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Coastal Bend College

St. Edward's University Austin

NSF Award No. 1759134
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Background: The National Science Foundation Dear Colleague Letter NSF 17—092 invited all eligible institutions of higher education to propose conferences to identify the most critical challenges and opportunities regarding undergraduate STEM education at HSIs and potential actionable solutions that could be included in the solicitations for the newly initiated HSI Program. This new program holds promise for continued improvements and enhancements in STEM education at Hispanic Serving Institutions in Texas and throughout the United States. Information gathered by the different conferences was to be used to inform future solicitations.

Rationale: PROMISE© *Providing Resources and Opportunities for Minorities in STEM Education* Conference

Laredo Community College, an HSI, proposed a conference to identify the most critical challenges and opportunities regarding undergraduate science, technology engineering and mathematics (STEM) education at HSIs, and to broaden participation of underrepresented minorities. Dr. Nora Garza, Dr. Agnes Flores, Dr. Rohitha Goonatilake, and Dr. Selina Mireles, worked to organize the conference for NSF grant award #1759134. The NSF HSI PROMISE© Conference was held March 21-23, 2018, in Laredo, Texas, with the Texas Hispanic Serving Institutions Consortium (TxHSIC) serving as the convener. The TxHSI Consortium was created under a grant to Laredo Community College from USDA National Institute of Food and Agriculture TEXE-2005-03443 in July 2005. The consortium unites public and private colleges and universities in Texas with similar student enrollments and needs in order to organize efforts, share successes and network to secure external funding for continued student success. The TxHSIC Board members include: Julia Garcia, Coastal Bend College, Dr. Gloria White, St. Edward's College, Evy Gonzalez, Texas State University, Dr. Agnes Flores, Texas A&M University Kingsville, and Dr. Nora R. Garza, Laredo Community College.

Dr. Laura Rendón, Dr. Amaury Nora, Dr. Juliet Ray and Dr. Jose Cabrales, as consultants for the grant, created a questionnaire, conducted focus groups, created a survey to evaluate the conference, and authored this policy brief (output). The IRB at Laredo Community College reviewed the quantitative and qualitative instruments. The policy brief reflects the input provided by over 147 participants, together with their expertise on ways forward to increase Hispanic STEM student success.

Cover: "Realizing the PROMISE© of Success for Latinx STEM Students"
Latinx Students in STEM Policy & Practice Brief includes the logos of the Texas Hispanic Serving Institutions Consortium, the National Science Foundation, and the logos of the investigators and board members. These educational institutions include 2-year and 4-year, public and private Hispanic Serving Institutions in Texas.

"This material is based upon work supported by the National Science Foundation under Grant No. 1759134. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation."

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Suggested Citation:
Rendón, L.I., Nora, A., Ray, J.M. & Cabrales, J. (2018). *Realizing the PROMISE of success for Latinx STEM students*. Laredo, Texas: Laredo Community College.

Authors' Notes:

1. Research findings in this policy and practice brief result from a National Science Foundation funded conference grant (NSF Award 1759134) awarded to Laredo Community College, Texas A&M University International and a collaborative of Texas Hispanic-Serving Institutions. The PROMISE© (*Providing Resources and Opportunities for Minorities in STEM Education)* conference, held in Laredo, TX on March 22-23, 2018, provided an opportunity for participants to outline key student and institutional challenges and opportunities to improve STEM education for Latinx students. The conference drew roughly 150 participants. The authors of this brief served as research and evaluation consultants for the PROMISE© grant. Laredo College is the new college name.
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2. The authors have chosen to use the term, Latinx, as a gender-neutral alternative to Latino, Latina or Hispanic. Latinx is a contemporary term that moves beyond gender binaries and is inclusive of Latinos and Latinas from all racial backgrounds and gender affiliations.

December 2018

EXECUTIVE SUMMARY

It is well documented that Latinx students are underrepresented in Science, Technology, Engineering and Mathematics (STEM) fields of study (NSF, 2017; Rendón & Kanagala, 2018). The National Science Foundation (NSF) supported the PROMISE© conference held in Laredo, Texas to identify key student and institutional challenges and opportunities to improve STEM education for Latinx students.

This policy and practice brief reports the significant findings of a mixed-methods research study. Findings were derived from: 1) a survey administered to PROMISE© conference participants and 2) focus group research with educators from two- and four-year institutions attending the conference.

The survey research findings highlight perceived challenges that could preclude the success of Latinx STEM students, as well as opportunities that could assist students to succeed. Focus group findings detail: 1) challenges faced by Latinx students, 2) challenges faculty faced working with Latinx students, 3) who or what was making a difference, 4) student and community cultural strengths, 5) important skills and competencies needed to succeed in STEM, 6) high-impact STEM practices, and 7) discriminatory practices that can preclude Latinx STEM success. Study conclusions and recommendations are offered as the role of NSF and other funding agencies remain important.

Introduction & Purpose

Given the long-standing underrepresentation of Latinx students in Science, Technology, Engineering and Mathematics (STEM) fields of study, as well as the cohort's growing presence in American society, this policy and practice brief is focused on elucidating key issues related to improving success for Latinx STEM students.

Its purpose is to outline significant findings of a mixed methods study involving: 1) a pre-conference survey administered to PROMISE© participants and 2) focus group research, which included educators from two- and four-year institutions attending the conference. The study was intended to identify STEM student and institutional challenges and opportunities, factors and experiences that enhance or preclude STEM achievement and recommendations to foster student success.

A Critical Time for Latinx Representation and Success in STEM

Analyzing U.S. Census data, the National Action Council for Minorities in Engineering (NACME, 2013) indicates that by the year 2050 no one race/ethnic group will be a majority in the U.S. The Latinx population will grow from 17% in 2012 to a projected 26.8% in 2050, making this cohort the largest population of color, nearly one-third of the nation. This growing Latinx population has great potential to become a part of the next generation of scientists who will play a key part in advancing the future of American and world scientific innovations, including, for example, technology, health, agriculture, climate, energy, genetics and digital media. However, unless steps are taken to improve access and success for Latinx students in STEM, the cohort's potential will be seriously diminished.

Latinx Underrepresentation in STEM

A special tabulation by the U.S. Department of Education, National Center for Educational Statistics, Integrated Postsecondary Education Data System revealed the underrepresentation of Hispanics and African Americans in science, mathematics, and engineering at the associate, bachelor, master's, and doctoral levels (NSF, 2017). Tables 1 and 2 display the associate degree attainment in all sciences, engineering, and science and engineering technologies in 2014 as well as the bachelor's degree attainment in all sciences and engineering among Latino, White, and African American students.

Table 1: *Associate Degree Attainment in 2014*

Race/Ethnicity and Gender	*All Sciences (% of total) N = 83,567*	*Engineering (% of total) N = 4,409*	*S&E Technologies (% of total) N = 148,966*
Hispanic or Latino	16,254 (19.45%)	709 (16.08%)	20,979 (14.08%)
White, Non-Hispanic	41,800 (50.04%)	2,507 (56.86%)	87,297 (58.60%)
African American	10,591 (12.67%)	308 (6.99%)	19,018 (12.76%)

Table 2: *Bachelor's degree Attainment in 2014*

Race/Ethnicity and Gender	*All Sciences (% of total) N = 541,965*	*Engineering (% of total) N = 93,950*
Hispanic or Latino	64,195 (11.85%)	8,984 (9.55%)
White, Non-Hispanic	315,071 (58.13%)	57,811 (61.52%)
African American	49,048 (9.04%)	3,599 (3.82%)

Tables 3 and 4 display the percent of STEM degrees earned at the associate's and bachelor's level for Latinx students in 2014. Tables 5 and 6 represent the change in percentages of STEM degrees earned at the master's and doctoral level from 2004 to 2014.

Table 3. *Latinx Associate Degree Attainment in STEM Fields*

STEM Field	*Percent of Degrees Earned*
All S&E	19.28%
Biological Sciences	26.83%
Computer Sciences	12.15%
Earth, Atmospheric, and Ocean Sciences	9.56%
Mathematics and Statistics	31.64%
Engineering	16.08%
All S&E Technologies	14.08%

Table 4. *Latinx Bachelor's Degree Attainment in STEM Fields*

STEM Field	*Percent of Degrees Earned*
All S&E	11.51%
Biological Sciences	10.54%
Computer Sciences	9.74%
Earth, Atmospheric, and Ocean Sciences	7.36%
Mathematics and Statistics	7.90%
Engineering	9.56%

Methodological Approach

A mixed-method, qualitative and quantitative research approach was undertaken employing focus group and survey research. The survey and focus group research methods and areas to be studied were the result of meetings held with the PROMISE© conference principal investigators. Further, NSF funding priorities were taken into consideration to determine key areas of investigative inquiry.

Focus Group Research Method

For the qualitative study, a 10-item interview protocol was designed to probe into key areas related to the purpose of the study. These areas included, for example, challenges Latinx students face entering and succeeding in STEM, challenges faculty face working with Latinx students, who or what is making a difference for students, important student competencies, Latinx strengths, helpful STEM practices, possible discriminatory experiences and recommendations to foster success.

Given that all participants were recruited from the conference they were attending, convenience sampling (Wiederman, 1999) was employed. Two- and four-year college participants were recruited to participate in a one-hour focus group interview. Research and evaluation consultants conducted separate focus groups for two- and four-year college participants. The two-year college focus group included five participants, while the four-year college focus group was comprised of 11 educators. Because of the small sample size, the findings grouped the two- and four-year institutional responses together. It should be noted that there was no disagreement about responses made to any of the questions signifying that all participants shared the same views.

Participants held various professional titles and roles which included professor/instructor, dean, chair, program director, advisor/counselor, STEM Success Center Coordinator, grant administrator and director of strategic initiatives. About 50% were faculty members. During the interviews detailed notes were taken to ensure key ideas were captured. Table 5 depicts demographic information for study participants.

Table 5. *Focus Group Participant Demographics*

Background Information	Community College	Four-year Institution
Gender	Males: 2 Females: 3	Males: 2 Females: 9
Racial/Ethnic Identity	Hispanic: 3 White: 1 Asian American: 1	Hispanic: 4 White: 7
Highest Degree Earned	Bachelor's: 0 Master's: 4 Doctorate: 1	Bachelor's: 0 Master's: 5 Doctorate: 6
Years Spent Working in Education	0-3: 0 4-7: 1 8-11: 0 12 or over: 4	0-3: 1 4-7: 0 8-11: 2 12 or over: 8

Transcripts were analyzed, coded and organized to discern key themes. Each key theme was the result of at least three factors that collectively clustered to produce a major theme. To ensure trustworthiness of data, peer debriefing was conducted with the grant's principal investigators who reviewed the study draft to ensure accuracy and provide alternative views.

Survey Research Method

For the quantitative study, a 56-item survey instrument was developed to provide measures of pre-conference perceptions/beliefs regarding Latinx STEM students. Four sections were developed that addressed preconceived notions of: (1) Latinx students in STEM fields of study, (2) faculty support for Latinx STEM students, (3) STEM teaching and learning practices, and (4) factors and experiences that help Latinx students to succeed in STEM. The survey was administered prior to the beginning of the NSF STEM Conference to assess the perceptions, attitudes, and beliefs related to Latinx STEM students held by the participants prior to their participation in the conference.

Survey Sample

Forty participants were surveyed, but only 39 were useable surveys. Five items were examined to provide a descriptive profile of the participants: (1) gender (2) race/ethnic identity, (3) years of professional experience, (4) type of institutional affiliation, and (5) professional title held.

Table 6: *Survey Participant Demographics*

Background Information	Participants: N=39
Gender	Male: 10 (25.6%) Female: 29 (74.4%)
Race/Ethnic Identity	Hispanic: 25 (65.8%) White: 9 (23.7%) African American: 3 (7.9%) Asian American: 1 (2.6%) Unknown: 1 (2.6%)
Years of Professional Experience	Average for group: 16.8 years
Type of Institutional Affiliation	Two-year Public Institution: 18 (46.2%) Four-year Public Institution: 14 (35.9%) Two -year Private Institution: 0 (0%) Four-year Private Institution: 5 (12.8%) Non-profit Organization: 2 (5.1%)
Professional Title Held	50% of participants were Directors or Coordinators

There were no representatives from two-year private colleges. The descriptive profile revealed that the number of years of professional experience ranged from as little as 1 year of experience to a total of 44 years at an educational institution. Four participants reported having 15 years of professional experience, 3 reported 20 years of experience, while another 3 reported having 30 years of professional experience.

Quantitative Data Analysis

There were a total number of 56 items used to provide measures of the four major sections in the survey. An exploratory factor analysis was conducted on each section to arrive at significant overall scales underlying the 56 items (See Appendix A). Reliabilities for each scale were examined and composite scores (variables) were derived by summing up those items comprising the scales. A total of 14 variables were derived: (1) culture of support, (2) educational resources, (3) academic preparation of students, (4) sense of belonging, (5) faculty support for Latinx STEM students, (6) lack of STEM information to enter STEM fields, (7) standardized test scores, (8) faculty/student research interactions, (9) student involvement in research, (10) mentoring, (11) optimistic viewpoint, (12) financial assistance to engage in Latinx STEM activities, (13) family support, and (14) academic ability. Differences among those 14 variables by gender, ethnicity, and institutional affiliation were examined. In other words, were there differences in those perceptions because the participants came from a two-year versus a four-year institution, were women versus men, or because of their ethnicities? An analysis of variance (ANOVA) was performed on each of the 14 variables by gender, ethnicity, and institutional affiliation.

Survey Research Findings

There were no statistically significant differences among the different groups on the 14 variables. For that reason, the findings represent the perceptions of all respondents collectively. Overall, participants either agreed/strongly agreed or disagreed/strongly disagreed on the perceived challenges and opportunities represented by the 14 variables.

Perceived Challenges

Participants were concerned about the following major challenges which could preclude the success of Latinx STEM students.

Lack of Culture of Support

One of the most important factors impacting student persistence in college and academic success is the degree of support and encouragement experienced by college students, specifically Latinx students (Nora & Crisp, 2009; Crisp, Nora, & Taggart, 2009; Arbona & Nora, 2007; Rendón, 1994). This support and encouragement provided by significant others in a student's life is instrumental in predicting the retention of college students to degree attainment. The perception of the conference participants was that they did not feel that there is an adequate culture of support for Latinx students in STEM fields of study by faculty and family.

Lack of Educational Resources

Across the country, the significant decrease in state funding for higher education has led to the reduction and/or exclusion of educational resources for students. If educational institutions are to provide the varied support services that students need to succeed in college, these educational resources must be available (Rendón, 2018). Participants in the NSF STEM conference agreed that, currently, there is a lack of educational resources in the form of funding, summer learning programs, and credentialing of teachers.

Academic Deficiencies

College readiness, specifically in the areas of science and mathematics, has been noted as a key deterrent to the academic success of minority students (Crisp, Taggart, & Nora, 2015; Crisp & Nora, 2010). Many Latinx students do not possess the science and math backgrounds coming out of high school that will incentivize them to consider majors in STEM fields. The perception held by conference participants was that Latinx students did not possess a good academic preparation as they graduated from high school that would prepare them for a STEM major in college.

Poor Sense of Belonging

In a recent report published by the National Academies of Science, Engineering, and Medicine (2017), the most influential intrapersonal competency affecting the persistence of students to graduation was a student's sense of belonging at an institution. This construct has been found over and over again to predict the academic and social integration of students into their learning environment, as well as to have a positive impact on academic performance, persistence, and ultimately, graduation (Nora, Carales, & Rendón, 2016; Crisp, Taggart, & Nora, 2015; Hurtado & Carter, 1997; Freeman, Anderman, & Jensen, 2007; Hoffman, Richmond, Morrow, & Salome, 2002; Strayhorn, 2012). Conference participants believed that Latinx students do not feel a sense of belonging in STEM fields because of the lack of prior academic experiences centered on STEM activities.

Lack of Faculty Support for Latinx STEM Students

Overall, participants felt that there was not enough faculty support for Latinx STEM students in such things as: working effectively with students, countering a lack of interest and commitment to STEM fields, assisting in developing study skills, time management skills, employing high-impact teaching and learning methods in courses and labs (Kuh, 2008), mentoring students (Nora & Crisp, 2007), selecting Hispanic students to work in labs (Rendón, 2018) and helping students to find workforce opportunities.

Lack of STEM Information to Enter STEM Fields

A lack of good information always limits the options that individuals need to make important decisions. It is difficult to consider and select a major in a science field and consider a career as a scientist when students may not even know what they don't know regarding STEM areas. Participants in the conference believed that Hispanic students do not have the information about what it takes to enter a STEM field and consequently do not select and enroll in science, engineering, and math majors. While more and more K-12 schools are introducing information and experiences on STEM areas to their students, these activities and sources of information are not found across all school districts, specifically in those districts where the majority of the students are Latinxs or African Americans.

Limited Utility of Standardized Test Scores

Test bias found in most standardized tests is nothing new (Walpole, McDonough, Bauer, Gibson, Kanyi & Toliver, 2005). However, instruments assessing the ability of students to successfully complete a college degree are still being used throughout the country to admit students into colleges and universities. The perception of conference participants was that the use of test scores did not assist Latinx students to succeed in STEM, possibly because Latinx and African American students come to interpret those scores as an indication that they don't belong in college, leading to imposter syndrome (Kumar & Jagacinski, 2006).

Perceived Opportunities

Participants noted the following opportunities that could assist Latinx students to succeed in STEM.

Effectiveness of Faculty/Student Research Interactions

Overall, participants felt strongly that faculty/student research interactions were an effective way to meaningfully engage Latinx students in STEM education. Specifically, they felt these opportunities should be focused on: Research with a Faculty Member, Undergraduate and Graduate Research Involvement, Faculty Encouragement and Support, STEM Related Internships, and Engagement in Teaching Assistantships. These research and teaching opportunities with faculty have been shown to make a significant difference for students in developing their scientific knowledge and expanding their professional networks (Bosch, 2017).

Student Involvement in Research

Kuh (2008) found the following pedagogic practices had a positive impact on student success: learning communities, deep learning experiences, study groups, experiential hands-on learning, and field experiences. The evidence suggests that authentic research experiences support academic success, particularly in STEM fields (Lopatto, 2010) The participants strongly felt that because student involvement in research is an effective practice, it should be provided more widely.

Value of Mentoring

The value of mentoring is generally accepted in empirical quantitative and qualitative research as well as in practice, particularly for its wide-ranging advantages for minority students (Cohen, 1993; Crisp, 2011; Nora & Crisp, 2007). Participants strongly felt that mentoring experiences associated with early K-12 participation in STEM, that affirming and encouraging experiences provided by faculty, and that mentoring experiences provided in summer science camps can assist Hispanic students to succeed in STEM.

Optimistic Viewpoint

Research on student resilience suggests that academic optimism can be a strong protective factor, particularly for minority students (Byrk & Schneider, 2002). Participants believed that those Latinx students that possess an optimistic view of their ability to navigate the world of college are more likely to succeed in STEM.

Financial Assistance to Engage in Hispanic STEM Activities

Nora, Barlow, and Crisp (2006) and Cabrera, Nora, and Castaneda (1992) found that lack of financial resources is a key barrier to college access and completion for minority and low-income students. Moreover, Rendón, Dowd, and Nora's (2012) research revealed that there is strong

public interest in making the student aid system work more effectively for students and families at a time when the student body is becoming increasingly diverse. This perspective is mirrored in PROMISE participants' belief that if Latinx students are provided with the financial assistance to participate in summer science camps and other Latinx centered activities, this type of funding support will assist them to succeed in STEM.

Family Support

Strong evidence suggests that parental involvement (educational encouragement, monitoring, and support) has a significant impact on students' academic persistence (Mena, 2011). Participants strongly agreed that Latinx students with strong family support and encouragement were more likely to succeed in STEM. Involving parents in a variety of activities on campus, such as orientation and cultural functions, serves to increase parental involvement and encouragement.

Latinx Academic Ability

Research has demonstrated that academic ability is a significant predictor of student persistence (Kahn & Nauta, 2001). Participants strongly agreed that the academic ability of Latinx students helps them to succeed in STEM. Increasing academic support systems on campuses through mentoring, tutoring, and intrusive coaching are different ways in which educational institutions can increase the academic ability of students.

Challenges Faced by Latinx Students

Two- and four-year focus group participants identified several challenges faced by Latinx students.

Student Academic Preparation

Oftentimes, lack of academic preparation lands students in developmental education, which becomes a barrier to their academic progress, and many schools lack the courses to adequately prepare students for college (Hurtado & Kamimura, 2003). "They're testing into the developmental area, so then that becomes a gatekeeper," said one two-year focus group participant. A four-year college educator said, "I feel like we need to have leadership help addressing these issues because it's a really huge problem facing not only Hispanics (I think all Texas students), but they're not prepared when they enter the university."

Time Management

Today's student is likely to manage several school- and job-related commitments and responsibilities while attending college (Elling & Elling, 2000; Soares, 2013). When asked about the challenges impacting Latinx students faced in participating in STEM education, a four-year participant said, "For me, it's balancing work, working space [to study] and so a lot of our students have to work to go to school and support families." The push and pull of multiple commitments can impact the time students spend on campus connecting with faculty outside of the classroom and engaging in other activities, such as study groups and campus involvement.

Lack of Academic Confidence

Faculty and staff stressed that students are capable of succeeding in STEM but found many students that they worked with came with a preconceived notion that they could not succeed. For example, one two-year faculty member indicated that she developed a lesson for students. However, she did not share what she was teaching the students; she just showed them. "After two weeks of having taught them...I said, do you know what you are doing? I said, this is pre-algebra." For these students, they were already solving algebraic problems; however, previously when they heard the word "algebra" they automatically created a block by sharing that they "couldn't do algebra." Meaningful faculty-student interactions can positively influence students' academic confidence just as it was displayed through the two-year instructor's exercise (Griffin, Pérez, Holmes, & Mayo, 2010; Pérez, 2017). Other focus group respondents shared that students felt they were not starting on par with their classmates, and it was going to take them that much longer to accomplish their goals.

Challenges Faculty Faced Working with Latinx Students

When asked about issues faculty faced, focus group study participants noted several challenges as they sought to improve the success of Latinx students.

Need for Faculty Development

While students are typically more adept at using technology as a learning tool in and out of the classroom, participants agreed that some faculty members may need additional development to keep up with evolving technology. One four-year participant encouraged the acquisition of mini-grants for faculty who wanted to strengthen their technological skills to support their teaching. "Mini-grants for faculty who are self-aware about their need to change and improve their pedagogy would be important."

A two-year faculty member also alluded to the lack of K-12 teacher training in concentration areas (i.e., mathematics). "Students {in teacher preparation programs} take the two classes, they get the two grades and they move on, and for the rest of their life they're certified to teach mathematics." More faculty development was viewed as necessary to prepare future teachers with the strong foundation necessary to help students succeed in STEM.

Participants further indicated that teachers did not necessarily know how to teach important personal development skills such as confidence and perseverance. One four-year educator expressed: "We don't have teachers that understand how to teach this. So that whole idea of inquiry, [including] instructional design is an issue where you teach the idea of grit and perseverance." Teacher preparation was viewed as a necessity with a four-year educator indicating that some teachers would say they hated math even though they were teaching it. The educator elaborated: "The reason I went into math is because I had a great high school teacher…but it is really important that we pay attention to teacher education." Another four-year educator said: "only two percent of high school graduates in Texas have ever taken a computer science course."

Further, a four-year college educator expressed the importance of faculty development as it pertained to incorporating the arts in STEM, especially in the early years of a student's schooling experience. The educator noted:

> How can we…help redesign…so that engineering and technology and any arts are integrated throughout every core classroom beginning in elementary school, not at the high school level. That's another issue. The superintendents…will implement things for only gifted students, or for high school students, not realizing that in lower grade levels that would be more impactful.

Challenges Related to Educating Rural Students

Both two- and four-year college participants understood the unique issues facing rural students who often did not want to leave the familiarity of their surroundings. A four-year educator discussed how students did not want to leave their home contexts saying: "I remember last semester we had a student who was on the school newspaper, but she was a STEM student and now is working at the newspaper because she doesn't want to leave the area, and I think just her knowing that there are these opportunities maybe in El Paso or in San Antonio; maybe it's the cost of transportation, that's an issue that they face." Transportation was another challenge presented to rural Latinx students. A two-year rural educator shared: "…We cover 9500 square miles, nine counties and we're in the middle of nowhere and so it's very difficult for students to get to us… There are no buses out there; there are no trains or anything." Lapid (2017) asserts that although the negative impact of distance on college enrollment is smaller now, it is still influential for many students in college enrollment and postsecondary degree attainment, particularly at two-year and non-flagship four-year institutions. Although an educator can use video-conferencing for students to attend classes, access to reliable internet can be a challenge to rural students. A recent study by Rosenboom and Blagg (2018) indicated that approximately 3 million American adults lack access to higher education based on where they live. In addition, these people live more than 25 miles from a broad-access public university and do not have access to high-speed Internet necessary for online education. "Students would have to go to the corner store or the nearest McDonalds to get Internet because they could not get it at home," said the two-year college educator.

Who or What is Making a Difference?

Focus group participants discussed who or what was making a difference for Latinx students.

Student Support Initiatives

TRiO programs have been in existence for decades and have assisted countless students prepare for college and graduate school. These efforts have made a difference for students' success in STEM (Curtin & Cahalan, 2004). In addition to the support services that TRiO programs provided, one two-year participant suggested that a part of the success of these programs was the connection between the students and people they could relate to when they walked onto campus and participated in these types of programs. She said, "I came from the same background and their struggles were real to me because I've experienced them, so I am a relatable relationship where they can explore and express themselves to someone that had already been through those struggles." Two-year and four-year focus group participants also indicated that students experienced growth with STEM-related curricula, particularly in summer bridge programs, where students attend summer classes for six-weeks before beginning the fall semester.

Engagement in Faculty - Student Research

One way of increasing the interest in STEM education among Latinx students is to engage them in undergraduate research opportunities. Faculty can serve as research mentors and help students develop undergraduate research skills (Griffin, Pérez, Holmes, & Mayo, 2010). In some of the four-year focus group participants' campuses, undergraduate STEM programs required an authentic research experience as a part of student academic plans, which was a way to ensure engagement between faculty and students. One four-year participant shared that at his university, faculty were required to help undergraduates with their individual development plans. Faculty and students forged a relationship through research. "They [students] see them in the classroom, as well as out of the classroom, both at the academic level, as well as the professional development level." Involvement in faculty-student research experiences can ultimately increase students' confidence in research skills and heighten their awareness of opportunities in graduate STEM-related fields of study (Russell, Hancock, & McCullough, 2007).

Role Models

In addition to research, faculty can continue their relationships with their students as those students move through graduate school and become professionals in their field. Some faculty frequently asked former students to come back and speak to current students. One four-year faculty participant said, "The near peers have much greater influence than the faculty do in many ways on mentoring their career pathways." Alumni can be critical role models that motivate and encourage students to pursue different careers, particularly in STEM (Cabrales, 2013). Other ways that STEM alumni were engaged with students was through events such as "Career Speed Dating," where students could be exposed to different STEM careers. One participant noted:

> We had 20 alumni come and we kept it at 40 students so that two students can travel around and spend five minutes with the alum...even if they didn't necessarily want [or] weren't interested in chemical engineering. They can just talk about how their degree helped them pursue their interests.

Some alumni also came back to their alma maters to provide constructive feedback on research posters and serve as judges for research symposiums. Aside from providing feedback, Latinx students were able to see someone like them as products of their college/university and successfully transition to a STEM career.

Student and Community Cultural Strengths

During the conference there was discussion about Latinx student assets and the strengths present in their communities. Current research dispels deficit-based assumptions about Latinx students from low-income communities. For example, Yosso (2005) presents a Community Cultural Wealth model that includes the following forms of capital: familial, social, navigational, resistant, linguistic and aspirational. Similarly, Rendón (2018) presented findings based on essays written by Latinx STEM graduates (Rendón & Kanagala, 2018) and found that the graduates employed the following assets to persist toward degree completion: giving back, social justice consciousness, curiosity, family, responsibility, resistance, navigational, *ganas*/perseverance and academic. From their family unit, Latinx STEM graduates benefitted from Latinx Cultural Pedagogics, which included the family ethic of hard work, *cariño,* (feeling of being lovingly cared for) and moral and practical guidance (Rendón, 2018).

Focus group participants were asked what they believed were strong assets for Latinx students. These assets are described below.

Familial Capital

Focus group participants echoed that encouragement from family and the sense of *familismo* was a strength among Latinx students pursuing and succeeding in STEM education. One four-year participant said, "...community, teamwork skill-sets [are important strengths] because I think this cohesive network, you know the idea of family and teamwork, that is something that crosses all disciplines and is so important toward any career." Yosso (2005) refers to this as familial capital, where there is a commitment to community well-being and expands the concept of family to include a broader understanding of kinship. As students begin their college pathway, they bring with them this ability to expand their network and work with others like family. A two-year focus group participant shared, "Students are motivated by their families, they want to do better for their families...they want to elevate their status and help their parents and they want to help their siblings have the motivation to keep pushing and pursue their STEM degrees." A four-year focus group participant felt similarly sharing that because they are the first in the family to attend college, the students bring their pride and leadership. He said: "I've heard lots of them say they're very proud of being the very first in their family too. Like they're the leader in their family and they're looking forward to mentoring those that come after

them."

Family Values

"I think strong family values give them good teamwork skills" said one two-year focus group participant. Helping one another when they are struggling and providing encouragement to work hard in school were examples of family values that students brought to campus. With struggle also can also come encouragement and celebration. A four-year participant shared: "I think you know, celebrating small successes, maybe with family or friends or something in that capacity, as well as large celebrations [is important]" A two-year participant said: "A cultural strength is the value of hard work." Educators in the two-year focus group shared that students oftentimes saw their parents work hard and not in the best paying job. One participant shared:

> You know, I saw my parents work, work, work…they never told me anything about what to study or how to study – just go to school. Just because I know that my parents always went to work, it was my job to go to school, so that kind of value of work pays off. I think it is important, culturally.

Ceballo (2004) articulates that Latino parents maintained an almost unconditional support for education. "For these parents, an American education was viewed as the best and only route for their children to escape poverty" (p. 176). Parents often give their children advice to go to school with little to no guidance on what they should be studying to go to college (Ceballo, 2004).

Resilience

Participants shared that many of their Latinx students upon enrolling college brought with them their resiliency and a strong work ethic. A four-year focus group participant said, "I think instructors call it grit or resiliency… I call it stamina for the process. You have to have stamina to study something the first or second or tenth time before you get it." In STEM disciplines, it is likely that a lab test is not going to succeed the first time it is run. Students learn quickly from faculty and mentors that in STEM, one is going to fail several times before yielding a positive result. Understanding this notion, students learn to move forward and not be discouraged by failure.

Important Skills & Competencies Needed to Succeed in STEM

It is important that STEM education be aligned with workforce skills required in industry, academia, technology, and government. However, research findings (Radermacher & Walia 2013; Carnevale, Smith & Melton, 2011) indicate that competencies such as "written and oral

communication, project management, teamwork, problem solving, critical thinking, and interpersonal skills are frequently reported as lacking in STEM graduates" (Jang, 2015 p. 1). Identification of core skills can vary, but there appears to be agreement that competencies can be categorized into cognitive and non-cognitive abilities. For example, The New York Academy of Sciences (2016) indicates that in addition to mastering content knowledge, there are "essential skills" students must develop (i.e., critical thinking, problem-solving, creativity, communication, collaboration, data literacy, and digital literacy and computer science). The Academy also notes that "supporting attributes" (i.e., STEM mindset, agency and persistence, social and cultural awareness, leadership and ethics) "can facilitate the development of and enhance these essential skills" (2016, p. 4). PROMISE© conference participants understood that two types of competencies were needed: academic and personal development.

Academic Competencies

Basic academic skills in reading, especially scientific reading, could give students a solid academic foundation. Additionally, critical thinking and problem solving were viewed as essential competencies for STEM success, but educators noted that Latinx students were sometimes lacking in these essential skills.

Reading Skills

A foundation in reading was identified as important for students to succeed in STEM. A two-year college educator explained: "Reading is just the kind of overarching skill that is necessary and then…to stay in focus, it's reading scientifically and having that rigor to really look at the facts…Putting a strong vocabulary in place is necessary."

Critical Thinking

Participants understood the value of critical thinking skills. As one two-year college participant observed: "They have to be able to analyze themselves just to find what they're doing; figure out why they're doing it and be confident with what they've decided… Sometimes they don't have that critical thinking skill…You have to direct them and help them, even if it's pretty plain and clear. We say 'oh, it's a given or it's a no-brainer' or – but they can't see it. You have to take them step-by-step, and I think that they really need to have that critical skill of thinking, and I think a lot of them are still lacking with that." Similarly, a four-year educator indicated that: "To be a scientist you need…to become a critically thinking problem-solver and you also need the persistence."

Problem Solving

Problem-solving was also viewed as a valued skill. A four-year college participant expressed: "…A lot of it is about problem-solving to be successful in any of the STEM fields…that's why I got excited about computer science, and I think that working with our students and them solving

problems and bringing out the creativity and validating [students]…is really huge toward getting them to see themselves as this is a possible thing for me." Another four-year college educator noted that: "...It's really about how you become an engineer, and how do you start learning about the interdisciplinary nature of problem-solving."

Personal Development Competencies

Informants related that students needed to have a science identity, to view themselves as a scientist, and that students needed skills related to social intelligence (i.e., perseverance, confidence, and empathy). However, participants noted that these skills were not being taught.

Development of Science Identity

A four-year participant spoke about the importance of mentoring to expose students to STEM careers, to help them see themselves as capable of doing STEM and to see that opportunities exist for them beyond what they see in their communities.
"I think exposure… Like somebody said today…I'm passionate about the environment; I want to fix it and somebody noticed that I wanted to fix it and they said no, take the STEM route and not the environmental route and you're going to make it. So, they're not exposed to that. I ask my Anglo faculty friends all the time 'how did you decide that this was going to be the thing that you were going to do'…They say, 'I was sort of good at it, and noticed that I was good at it and then somebody came and told me how good I was at it'. I don't think Hispanic students get told how good they are at stuff sometimes; they don't get noticed for whatever reason, maybe because they're not…in your face...So, exposure, exposing them to the careers…"

Perseverance

Staying the course despite encountering failure was perceived to be a valuable asset. As one four-year educator noted: "Just be persistent and try again…"

Confidence

Noting that Latinx students are often humble and respectful, a four-year participant explained the importance of having the confidence to challenge situations and to approach a professor to ask questions or to challenge an idea. The participant explained how it was important to empower students:

We should empower [students]… But it's something that I tell my students. I say I have a perspective, and I want you to let me know when it doesn't match yours, because you may change my mind and it's okay. I mean when you go on interviews, especially with companies like Microsoft or Google, they'll tell you an answer is wrong to see if you defend it. So, we have to tell students… some answers, in computer science anyway, are not always black and white.

Tolerance for Failure

Confidence was also important because in STEM experiencing failure is a part of being a scientist especially with experiments, which require learning from trials that may succeed or fail. Latinx students often did not understand that failure in science is a norm given that experiments often result in failure, but one must keep trying until success is achieved. As one two-year college participant noted: "You're going to be wrong nine out of ten times, and I think that's what's missing. I think that's not always being taught, and students have this preconceived notion that if I don't get it right, then I don't understand it." A four-year college educator expressed: "Ninety percent of the time things are going to turn out one of two ways. It's either going to be a success or it's going to be a great learning experience. We don't have to talk about failure."

Empathy

A four-year participant indicated empathy was a skillset that Latinx students had in their culture. The educator noted "It's an advantage that [Latinx students] bring to the table."

High-Impact STEM Practices (HIPs)

The research literature has identified a number of high-impact pedagogic practices (Kuh, 2008; Rendón, 1994; Rendón, 2009; Rendón, 2018) that have been effective with college and university students. Among these HIPs include 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 6. portrays STEM HIPs that two- and four-year college educators identified. In some cases, grants had allowed institutions to employ these practices. Because there is research to substantiate the use of these HIPs, NSF and other funding agencies should consider supporting these practices.

Table 7. *High-Impact STEM Practices.*

STEM HIP	Examples
Summer Bridge Programs	Early exposure to curriculum; promotion of student engagement
Living and Learning Community	Student learning communities connected to STEM areas
Research with a Faculty Member	Joint research projects with faculty
Articulation Agreements	Coordinated with schools, colleges and universities to prevent loss of course credits
Inquiry Learning	Design of student experiments; involvement in independent investigations

Study Abroad	International research projects and learning experiences
Capstone Courses	Culminating, integrative learning experiences
Experiential Learning	Hands-on experiences; active involvement
Peer-Led Team Reading	Peer teaching
Debate Club	Foster ability to articulate coherent arguments
NASA MEI (MUREP Educator Institutes) Student Teacher Project	Student STEM certification
Community-Based Projects	STEM projects in communities
Contextualized Reading and Writing	Connection of reading and writing to specific content areas
Student Research Assistantships	Paid student assistantships to engage in research and connect with a mentor
Conference Presentations	Involvement in professional organizations based on research projects
Internships	Work experience at STEM national and international agencies

Discriminatory Practices

Carnevale, Smith and Melton (2011) note that women, as well as Latinxs and African Americans, are underrepresented in the STEM workforce, while Asians represent a larger share of the workforce relative to each group's position in the labor market. Further, the STEM workforce tends to draw from Whites and males who earn more than women and people of color despite the fact that STEM jobs pay well. In addition, the U.S. is relying on foreign-born workers to fill STEM workforce demands. These inequities point to the need to examine the extent that discriminatory practices work against women and people of color in STEM.

Research indicates that many widely-held views about the Latinx population and women are framed with deficit-based assumptions. These include the notion that Latinx students and communities are inferior (Rendón, Kanagala, & Bledsoe, 2018). Low-income students are often referred to as "marginal" learners, "at risk," and "culturally deprived" (Conchas, 2007; Valenzuela, 1999; Volpp, 2000; Valencia, 2010; Moll et al., 2001; Yosso, 2005; Rendón, Nora, & Kanagala, 2014; Zambrana & Hurtado, 2016; Stanton-Salazar, 1997). Another form of discrimination is known as "racial microaggressions." Sue et al. (2007) indicate that: "Racial microaggressions are brief and commonplace daily verbal, behavioral, or environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative racial slights and insults toward people of color" (p. 1).

Women and people of color in male-oriented professions such as STEM have experienced discrimination and can also suffer from implicit bias, the unconscious attribution of specific qualities on a racial or gender group that can result in negative stereotyping. The Kirwan Institute

(2015) notes that implicit biases can cause people to have feelings and attitudes about others based on characteristics such as race, ethnicity, age, and appearance. The origin of these associations include exposure to early direct and indirect messages, as well as messages conveyed through media and news programming.

Educators were asked to respond to what they perceived to be possible discriminatory practices at their institution related to racial bias and sexism in the recruitment, retention and graduation of Latinx STEM students.

Stereotyping and Labeling

Two-year college educators noted that their institution had laws to prevent discriminatory behavior, yet some existed. One educator spoke about how students were sometimes "labeled" and told "they weren't going to make it."

Microaggressions

Another two-year college educator referred to microaggressions saying: "Some of those kinds of things are still prevalent and that could be just ignorance of some people…They just may be making a snide comment… But there is still probably an impact with different cultures from bad discriminatory practices that did occur in the past. It's hard to get over."

Sexist Practices

A two-year college educator noted discrimination in the "lack of support for females in STEM. You know, the promotion when a female is strong in math and science. That kind of recruitment onward doesn't always happen and why it doesn't is beyond me." Another four-year educator noted: "I have a horrible time trying to hire, always, female faculty, much less Hispanics. It's just you have to create – I mean I always push it through but I'll get arguments like, 'I thought you wouldn't hire someone that couldn't get tenure,' and it's only one or two people…The rest of the faculty are very inclusive and they're very open, but you have one or two voices and you have to try to control those voices and get beyond it, but it's hard. In a way it's just a climate that is not an inclusive environment."

Lack of Leadership to Promote Inclusive Environment

Four-year college participants expressed how the issue of discrimination needed to be addressed by institutional leaders. One participant noted that the leadership needed to come "from the top down, from the President and the Provost and all the deans." This leadership was important especially when announcing new hires which needed to include women and people of color. One participant noted that bias "happens very often in higher education when hiring faculty. Sometimes not even on purpose, it's just unconscious." Participants also noted other forms of discriminatory practices that worked against inclusivity, including posters with negative comments on campus and a student who wrote racially charged letters.

Conclusions

Study participants provided critical information that yielded the following conclusions.

1. The problem of poor Latinx student under-representation in STEM should not be blamed solely on students. Rather, the problem can also be related to:
   a) Long-standing, unaddressed societal conditions (i.e., poverty and related social ills)
   b) Structural inequalities (i.e., lack of culture of support for students, limited resources, poorly resourced schools, K-12 and college faculty who lack STEM preparation and who are unfamiliar with how to work with Latinx students)
   c) Educational policies that preclude high-level student achievement and potential for completing college programs of study (i.e., lack of articulation agreements between two- and four-year institutions and over-emphasis on K-12 testing that promotes rote memorization as opposed to intellectual processing).
   Participants noted that low-income Latinx students typically have trouble articulating challenges they face so faculty can't help them. Living with limited financial resources means students are unable to cover the full cost of college, including tuition, housing, child care, materials and transportation, a situation that poses dire consequences for students.
2. Living in rural areas, also termed educational deserts, can deter Latinx students from seeking opportunities found outside their living contexts. Oftentimes, educational and financial opportunities to achieve an educational goal are not discussed in high schools and seldom do higher education recruiters visit those areas. Moreover, rural students are often place-bound and reluctant to leave their communities (McDonough & Gildersleeve, 2010). Instead of college, they often take jobs that do not require a college degree when that allows them to stay in their home context. Even when higher education institutions are found within an acceptable distance, there is a reluctance to leave home (McDonough & Gildersleeve, 2010).
3. The deficit-based narrative that most, if not all, low-income Latinx students cannot do STEM, are unmotivated, lack perseverance and bring little to the college experience is unfortunately still entrenched in society. Most STEM faculty are unaware of the personal and cultural strengths of Latinx students or how to leverage these assets (Yosso, 2005; Rendón, 2018).
4. To foster Latinx STEM success major challenges need to be addressed. Among these include: building a culture of support, providing adequate educational resources, addressing academic deficiencies early in schooling, promoting a sense of belonging, preparing faculty to teach in STEM and to work with Latinx students, providing students and families extensive information about what it takes to enter STEM fields and finding better ways to assess students that go beyond the use of standardized tests.

5. STEM faculty development in both K-12 and higher education is a critical need as faculty must be able to effectively engage students with STEM HIPs, build validating relationships with students, become technologically savvy, address critical skills and competencies students need to succeed, gain a better understanding of Latinx students and communities, work with an asset-based framework and overturn deficit thinking that all too often results in students internalizing the notion that they are failures and cannot possibly be successful in STEM.
6. Articulation agreements in diverse STEM fields should be a primary focus in higher education.
7. STEM education does not occur in a vacuum. Relationships involving connections with business and industry, alumni, Latino families and communities need to be fostered and strengthened.
8. Despite student and institutional challenges, opportunities exist. Among these include teaching and learning practices that build relationships among students and faculty, the use of STEM HIPs, mentoring, role models, student financial support, family support, a focus on strengthening academic ability, and student support services initiatives.
9. Both academic competencies (i.e., reading, critical thinking, problem-solving) and personal development skills (i.e., science identity, perseverance, confidence, tolerance for failure and empathy) are needed to succeed in STEM. Rather than STEM, there are advocates of STEAM education. STEAM adds the "A" for the arts, a means for adding a wider array of academic and personal skills, including creativity, team building, cultural understanding, and determination along with critical thinking, and the ability to apply and integrate knowledge in a complex world. Advocates of STEAM believe that adding the arts can provide a broader range of educational and career-path opportunities and a more well-rounded academic experience that will help students in their life pursuits.
10. Discriminatory practices in the form of stereotyping, microaggressions, sexism, and non-inclusive environments persist and need to be addressed.
11. Rural colleges and universities need additional support in terms of funding and resources.

Recommendations

The following recommendations are offered as the role of NSF and other funding agencies remains important.

1. Comprehensive, Asset-Based STEM Programmatic Initiatives. NSF and other funding agencies should ensure that projects designed to foster Latinx student success in STEM are framed with an asset-based paradigm that leverages student and community strengths and that addresses the myriad of academic, social and emotional issues students confront. A comprehensive STEM approach can ensure that students receive a well-rounded academic experience that builds both academic and personal development skills students will use in the workforce and in society. Rural HSIs should receive special funding consideration.
2. STEM Faculty Development Programs. Support is needed for STEM Faculty Development Programs that focus on assisting faculty to work with STEM HIPs, become adept in the use of technology, recognize and leverage Latinx student assets, learn to work effectively with students from underserved communities and become supportive, validating agents, mentors and role models. Faculty should also be able to recognize and address STEM inequalities and discriminatory practices that negatively impact women and students of color. Along these lines, mini grants, workshops, retreats and innovative instructional design projects could be helpful to STEM faculty.
3. Student Financial Support. Given the legacy of poverty and its related ills, it is imperative that financial support be continued in various forms such as scholarships, national and international internships, teaching assistantships and fellowships.
4. Early STEM Preparation Programs. By the time Latinx students graduate from high school it may be too late to ensure that they have a solid academic foundation to succeed in STEM. Consequently, NSF and other funding agencies should support a GEAR UP Program type of approach with a focus on STEM education beginning no later than the 7th grade. HSIs could "adopt" feeder schools and work closely with alumni and community members to build and sustain a STEM culture of success in schools, college and universities.
5. STEM Articulation Agreements. It is important that two- and four-year colleges and universities create a seamless pathway to earning a STEM degree. Support is needed to allow faculty and administrators to develop articulation plans, processes and policies.
6. STEM Student Support Services. Latinx STEM students could benefit from STEM Student Success Centers and other dedicated spaces for students to engage in peer networking, career preparation, undergraduate research opportunities, and community service. Student support services could also include advising, mentoring, graduate school readiness and financial aid opportunities.

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Appendix A. Mean Scores and Reliabilities for Variables Derived from Quantitative Data

Variable	*Reliability (Cronbach Alpha)*	*Mean Score*
Challenges:		
Culture of Support	.807	2.84
Lack of Educational Resources	.749	3.81
Academic Preparation of Students	.632	2.53
Sense of Belonging	.745	2.36
Faculty Support for Hispanic STEM Students	Single item (not a scale)	2.83
Test Scores	Single item (not a scale)	2.65
STEM Information to Enter STEM	Single item (not a scale)	2.83
Opportunities:		
Strong Faculty/Student Research Interactions	.929	4.43
Student Involvement in Research	.888	4.40
Mentoring of STEM Students	.945	4.45
Optimistic View	.807	4.23
Financial Assistance to Engage in Hispanic STEM Activities	.761	4.26
Family Support	Single item (not a scale)	4.50
Academic Ability	Single item (not a scale)	4.32