RETHINKING POLICY AND PRACTICE FOR STEM EDUCATION:

New Hispanic Perspectives

HACU

HISPANIC ASSOCIATION OF COLLEGES AND UNIVERSITIES

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LETTER FROM THE PRESIDENT AND CEO OF HACU

On behalf of the Hispanic Association of Colleges and Universities (HACU), I present to you *Rethinking Policy and Practice for STEM Education: New Hispanic Perspectives*. This report sums up a comprehensive review of STEM education as it relates to Hispanics, one of the nation's fastest growing populations. A series of policy and practice recommendations are offered to provide stakeholders with strategies that can guide innovation and pedagogy from pre-kindergarten through graduate education.

This report also emphasizes the urgency to take action to compel policy makers and education advocates to invest in Hispanic STEM education. Hispanic-Serving Institutions (HSIs) enroll two-thirds of the 3.8 million Hispanic college students and impressively produce 40% of STEM bachelor's degrees earned by Hispanics. HSIs are playing a lead role in educating the current and future Hispanic STEM workforce.

We must reverse funding inequalities at HSIs and school districts with high Hispanic enrollments. According to the U.S. Census Bureau, Hispanics stand to represent 74% of all the new American workers entering the labor force between 2010 and 2020. Strengthening HSIs in general, and especially in STEM education, should be a national priority. Thus, this report should serve as a call to action to increase funding for HSIs and other sectors of education to ensure that the nation remains competitive in the global STEM-driven economy.

HACU is indebted to its STEM Task Force members for their invaluable time and effort in the development of the report's content. This report was made possible thanks to the generous support of the National Science Foundation. Their grant allowed distinguished scientists and senior university leaders of the task force to come together for a series of meetings that yielded the conclusions and recommendations in this report.

We urge you to peruse this report and to consider its recommendations for appropriate action.

Sincerely,

Antonio R. Flores
President and CEO
Hispanic Association of Colleges and Universities

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INTRODUCTION

With the assistance of the National Science Foundation, the Hispanic Association of Colleges and Universities (HACU) convened a STEM Task Force, a diverse panel of scientists and university administrators, to help develop a set of recommendations on both policy changes and high-impact practices to improve the participation and success rates of Hispanics in science, technology, engineering, and mathematics (STEM) fields.[1] Hispanics continue to be underrepresented in STEM fields, both in undergraduate and graduate studies and in professional STEM careers.[2] Hispanics make up 16 percent of the overall U.S. labor market and are expected to account for one out of every two new workers entering the workforce by 2025; 66,000 are turning 18 every month.[3] The U.S. Census Bureau projects[4] that Hispanic demographic growth in the U.S. will continue throughout this century, the persistent underrepresentation of Hispanics in STEM poses a serious challenge for an economy (and on national security) increasingly dependent on innovation in science and technology.

We should note at the outset that our understanding of STEM careers includes a wide range of possibilities requiring a variety of levels of education or certification. Without being exhaustive, the list of careers would certainly include university-, government-, and corporation-based research scientists, college and university science faculty and technicians, PK-12 science teachers, a wide variety of technicians, scientists and engineers working in an array of industries, especially in information technologies, and science and technology-related entrepreneurs. To this list might be added other non-STEM professions like accounting, finance and law that in some industries require competency in STEM concepts in order to function effectively. Finally, but not least, there is a universal need for some measure of scientific literacy in a culture in which critical political and social issues require a basic understanding of science, its possibilities and limitations, in order for there to be informed public opinion and genuinely democratic decision-making. One need only think of current issues around the environment, military technology, energy, and communications, to understand why improved STEM education is critical for everyone. Failing to be scientifically literate is to be deprived of intelligent participation in the world today.

We also note that the Hispanic community in the United States is not monolithic. It includes Hispanics whose ancestors lived in what is now the U.S. since before we became a nation, as well as the most recent immigrants. It includes Hispanics whose ancestors lived in what is now the U.S. since before it became a nation, as well as the most recent immigrants. It includes populations who trace their roots directly to Spain, as well as much larger numbers whose more immediate roots are in Mexico, Puerto Rico, Cuba, or other nations in Central and South America. It includes individuals and families who enjoy great wealth, education, and privilege, some in the white- and blue-collar middle class, and too many in the lowest deciles of the socio-economic ranks. We say this to remind ourselves and our readers that, while some level of generalization is necessary, we should also be alert to this diversity of the U.S. Hispanic population and avoid falling into inaccurate and harmful stereotypes.

Bearing in mind what has just been said, it is nevertheless likely that one of the (if not *the*) chief contributors to the underrepresentation of Hispanics in STEM fields is disproportionate levels of poverty and attendant limitations on educational opportunity. A recent Census Bureau report[5] noted that the Hispanic poverty rate reached a historic low of 18.3 percent in 2017 marking steady improvement since the beginning of the Great Recession. However, that is still more than twice the poverty rate for non-Hispanic whites and leaves almost one in five Hispanics in poverty. More tellingly, ChildTrends reports[6] that 25 percent of Hispanic children under 18 live in poverty, compared with 11 percent of non-Hispanic white children. These disproportionate levels of poverty have consequences for many Hispanics throughout the educational pipeline.

1 We are grateful to the National Science Foundation for grant 1457940 that supported the participation of this Task Force over a series of three meetings in this effort.

2 See, for example, Pew Research Center, "7 Facts About the STEM Workforce," January, 2018, at https://www.pewresearch.org/fact-tank/2018/01/09/7-facts-about-the-stem-workforce/, which notes that while Hispanics comprise16 percent of the national workforce, they make up only 8 percent of the STEM workforce.

3 The Changing U.S. Workforce: The Growing Hispanic Demographic and the Workforce. A Research Report by the Human Resource Management and the Congressional Hispanic Caucus at https://www.shrm.org/hr-today/public-policy/hr-public-policy-issues/Documents/15-0746%20CHCI_Research_Report_FNL.pdf

4 See U.S. Census Bureau, 2014 National Population Projections: Summary Tables, Tables 10 and 11, at http://www.census.gov/population/projections/data/national/2014/summarytables.html.

5 U.S. Census Bureau, Ashley Edwards, "Hispanic poverty rate hit an all-time low in 2017," February 27, 2019, https://www.census.gov/library/stories/2019/02/hispanic-poverty-rate-hit-an-all-time-low-in-2017.html.

6 ChildTrends, "Children in Poverty," January 2019, https://www.childtrends.org/indicators/children-in-poverty.

INFORMAL LEARNING AND SCIENCE LITERACY

While professional STEM careers demand years of intensive formal education in science, informal learning is also important, both to support the science literacy of the general public and to inspire the rising generation of STEM workers.[7] Informal STEM learning takes many forms, for example, science museums and zoos, educational information at parks and recreation areas, popular science writing in various media. The ubiquity of television gives it enormous social power to shape the public perception and understanding of science. The two Cosmos series, featuring Carl Sagan and Neil deGrasse Tyson, are examples of popular science at its best. Regrettably, not all TV programming that is billed as science is careful to delineate or even raise the question of the boundaries between science and pseudo-science, with the result that important educational opportunities are lost and confusion about the nature and methods of science is proliferated.

Nevertheless, Falk and Dierking[8] argue that:

> A growing body of evidence supports the contention that the public learns science in settings and situations outside of school. A 2009 report by the National Research Council, *Learning Science in Informal Environments: Places, People and Pursuits,* describes a range of evidence demonstrating that even everyday experiences such as a walk in the park contribute to people's knowledge and interest in science and the environment.

Their contention is that the 95 percent of people's lives spent out-of-school is more important for general science literacy than the 5 percent of in-school science education. Unfortunately, students less likely to attend high quality formal schools are also less likely to have opportunities for informal science experiences:

> Forty years of steadily accumulating research shows that out-of-school, or "complementary learning" opportunities are major predictors of children's development, learning, and educational achievement. The research also indicates that economically and otherwise disadvantaged children are less likely than their more advantaged peers to have access to these opportunities. This inequity substantially undermines their learning and chances for school success.[9]

Clearly more must be done to assure that Hispanic children from low-income families (and other low-income underrepresented minority children) are exposed to informal science learning opportunities. School-sponsored field trips are one immediate approach, but not nearly as effective as family excursions. Cost and limited availability can be barriers for visits to science museums, planetariums, aquariums, etc.; efforts should be made to reduce these barriers. For low-income families, the opportunity cost is perhaps the most formidable barrier to family participation.

The Federal STEM Education 5-Year Strategic Plan (May 2013) recognizes the importance of these out-of-school STEM learning opportunities, but does not directly connect it to broadening the participation of currently underrepresented minorities in STEM careers.[10] Clearly both targeted and culturally relevant outreach and adequate funding will be key in effective implementation of the important goals set forth in this Plan.

Policy Recommendation:

Continued strong support for high quality informal science learning opportunities at public venues (e.g., national parks and museums) along with targeted outreach to underrepresented minorities (both children and adults) is essential to making these opportunities available to all.

Practice Recommendation:

Educational institutions, STEM research facilities and corporations should make the relatively low-cost investment to create informal science learning opportunities for students (and ideally their families) who would not otherwise have access to them.

7 See, for example, the Center for the Advancement of Informal Science Education at http://www.informalscience.org/what-informal-science.

8 John H. Falk and Lynn D. Dierking, "The 95 Percent Solution: School is not where most Americans learn most of their science," The American Scientist, Vol. 98, p. 488, at http://www.informalscience.org/sites/default/files/FalkandDierking95perc.pdf.

9 Harvard Family Research Project. 2007. "Findings from HFRP's study of predictors of participation in out-of-school time activities: Fact sheet." http://www.hfrp.org/ content/download/1072/48575/file/findings_predictor_OSTfactsheet.pdf, cited in Falk and Dierking, op.cit., pp. 491-2.

10 Committee of STEM Education National Science and Technology Council, "Federal Science, Technology, Engineering and Mathematics (STEM) Education 5-Year Strategic Plan" May 2013, pp. 9-11, 22-26, https://www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf.

PRE-K AND KINDERGARTEN

While there may be some debate about the value of pre-kindergarten programs,[11] some assumptions seem intuitively clear:

1. Children have a better chance of academic success when they enter formal education "school-ready,"[12] i.e., prepared physically, intellectually, emotionally and socially for the classroom environment, with positive attitudes toward learning. NAEYC (the National Association for the Education of Young Children) notes that readiness pertains not only to the child, but to the family, the school and the community.

2. Growing up in a warm, supportive and stimulating family environment is important to school readiness. The cultural importance of family among Hispanics is sometimes in competition with other economic and social pressures.

3. For at least some children, pre-kindergarten is a favorable environment for assuring school-readiness. Consequently, it needs to be high quality, conveniently available and free.

4. For those Hispanic children whose home language is Spanish, pre-school may be especially important to bring English skills up to school-readiness.

5. School readiness is important to STEM education since it becomes harder to overcome deficits in reading comprehension and math skills if one falls behind grade level early on.

6. Schools also need to be "child-ready" and have teachers and staff with the cultural competencies to understand students' backgrounds and shape learning strategies to best fit the students that attend.

Policy Recommendation:
High quality, convenient and free pre-K and kindergarten programs should be available to all children to assure their school readiness. Likewise, "child-ready" programs should have the cultural competence to educate children from diverse backgrounds.

Practice Recommendation:
Pre-K and kindergarten should include a strong hands-on science curriculum and proactive parental engagement programs focused on experimental science and math developmental education.

11 See, for example, Andrew Flowers, "Is Pre-K All It's Cracked Up To Be?" Jan. 5, 2016, http://fivethirtyeight.com/features/is-pre-k-all-its-cracked-up-to-be/, and Sneha Elango, Jorge Luis Garcia, James J. Heckman, and Andrés Hojman, "Early Childhood Education," November 2015, National Bureau of Economic Research Working Paper 21766, http://www.nber.org/papers/w21766.pdf.

12 See, for example, Zero to Three: National Center for Infants, Toddlers and Families, "The School Ready Child (Infographic)," at http://www.zerotothree.org/public-policy/school-readiness-infographic.html?referrer=https://www.google.com/, or National Association for the Education of Young Children, "Where we stand on school readiness," 2009, at https://www.naeyc.org/files/naeyc/file/positions/Readiness.pdf.

ELEMENTARY SCHOOL

As the foundation of formal learning, elementary school plays an important role in laying the groundwork for all future STEM education. Basic communication and arithmetic skills, as well as solid study and learning habits, need to be solidly formed at this stage. If English language proficiency has not been achieved at home or in pre-K, a strong and supportive ESL will be critical. For some Hispanic children, ESL is especially important: as of 2014, 28.6 percent of Hispanic public-school students are participating in programs for English language learners.[13]

Elementary school is also an opportunity for learning the range of career opportunities beyond those most immediately familiar from one's own family and neighborhood. Exposure to positive images of scientists (especially Hispanic scientists) and to realistic portrayals of STEM work in action can be particularly impactful at this stage. It hardly needs saying that one cannot aspire to what one doesn't know and for any career to be considered children must be able to identify with real (or fictional) practitioners in that career.

De facto segregation of Hispanic and other minority and low-income children, inequities in school funding and consequently in teacher quality, resource availability, curricular rigor, etc. are also relevant at this stage. Elementary school children who do not receive a solid foundation in basic skills are particularly disadvantaged in later STEM courses. Interventions by other institutions can be helpful supplements but cannot entirely make up for systemic problems.

In particular, elementary level classes in science led by teachers with solid training in science education need to be introduced as early as possible, with an emphasis on fostering a curiosity about the world around us and the importance of careful observation and other elements of the scientific method. The interconnectedness of the natural world lends itself to a natural study of ecology and lays the foundations for later appreciation of the systematic and collaborative nature of the scientific enterprise.

Policy Recommendation:
The single most important recommendation is equitable funding for public schools and other policies to assure more and better elementary school science instruction by qualified science and math teachers. Strong English as a Second Language programs that are supportive of students learning English are also a priority.

Practice Recommendation:
Outside partners can play an important role in supplementing elementary school curriculum by providing experiences of science and scientists in action. The power of Hispanic scientists as role models for students can hardly be overestimated.[14]

13 U.S. Department of Education, Digest of Education Statistics 2015, Table 204.25. Public school students participating in programs for English language learners, by race/ethnicity: Fall 2009 through fall 2014, at https://nces.ed.gov/programs/digest/d15/tables/dt15_204.25.asp.

14 While the importance of role models seems intuitively clear, the research literature is still somewhat sparse. See e.g., Antronette K. Yancey, MD, MPH; Judith M. Siegel, PhD, MSHyg; Kimberly L. McDaniel, PhD, **Role Models, Ethnic Identity, and Health-Risk Behaviors in Urban Adolescents**, Arch Pediatr Adolesc Med. 2002;156(1):55-61. doi:10.1001/archpedi.156.1.55 at http://jamanetwork.com/journals/jamapediatrics/fullarticle/191394; and Penelope Lockwood, "Someone Like Me Can Be Successful": Do College Students Need Same-Gender Role Models?, Psychology of Women Quarterly, 30 (2006), 36-46, at https://www.hw.ac.uk/documents/same-gender-role-models.pdf. Both of these studies suggest that role models who share gender or ethnicity may be more important for students who identify with the relevant "out-groups."

MIDDLE SCHOOL

Middle school represents an important juncture in the educational pipeline. Educational and career aspirations begin to assume a more realistic shape. With the progression to algebra, math education rises to a new level of abstraction. Formal science education as part of the curriculum becomes more common. Needless to add, middle school education takes place in the context of the often chaotic world of early adolescence.

At this stage, students need more intensive counseling about high school course selection in view of readiness for higher education. Especially is this true of students who would be the first generation in their families to go to college. Without the cultural capital at home to guide the educational process, these students depend on counselors at school and other mentors in or out of school for critical information and support. Interventions at this stage can begin to address the college admissions and financing issues, as well as career options and the requisite educational backgrounds.

Here and in high school the shortage of trained academic counselors is a serious issue. As of 2017, the ratio of students to public school counselors in the United States is 442 students per counselor.[15] What's worse, "in public schools, counselors spend less than one-third of their time talking to students about education after high school."[16] Not surprisingly, as school size and percentage of students on free or reduced price lunch goes up, the proportion of counselor time spent on postsecondary admissions decreases.

Adult STEM career role models and exposure to scientific/technical work in progress, in research or manufacturing laboratory settings, can be particularly effective at this stage and can help students set realistic goals and expectations about their educational and career aspirations. At this stage also, Hispanic college students can be particularly effective as role models of educational progress. They may even be able to provide helpful advice about the practicalities of college selection and admission and the importance of a rigorous middle and high school curriculum.

Middle school may seem early for some of these issues, but in 2009-10, 104,756 students dropped out of school by grade 9.[17] This brain drain reinforces the importance of early intervention.

Policy Recommendation:
Providing adequate numbers of well-trained counselors to address academic issues and college admissions as early as middle school should be a high priority.

Practice Recommendation:
Programs that provide middle school students with exposure to models of STEM professionals, to STEM research and work experiences, and to successful Hispanic college students, especially in STEM fields, can be important supplements to, but not substitutes for, high quality STEM teaching and counseling.

15 Ibid., Table 213.10. Staff employed in public elementary and secondary school systems, by type of assignment: Selected years, 1949-50, https://nces.ed.gov/programs/digest/d14/tables/dt14_213.10.asp.

16 National Association for College Admission Counseling (NACAC), Research to Practice Brief, "Effective Counseling in Schools Increases College Access," 2006, p. 3, http://www.nacacnet.org/research/research-data/Research%20Member%20Only/McDonough.pdf.

17 U.S. Department of Education, Digest of Educational Statistics 2015, Table 219.50. Number and percentage of 9th- to 12th-graders who dropped out of public schools, by race/ethnicity, grade, and state or jurisdiction: 2009-10, at https://nces.ed.gov/programs/digest/d15/tables/dt15_219.50.asp.

HIGH SCHOOL

Virtually everything just said about middle school applies as well to high school: college and career aspirations ordinarily become more concrete, course selections become more critical, and solid counselling regarding college, career, and courses becomes more necessary.

A strong math curriculum through and beyond algebra is essential if a student is to be prepared for college level STEM study. According to Cliff Adelman in his classic "Toolbox" studies,

> Of all the components of curriculum intensity and quality, none has such an obvious and powerful relationship to ultimate completion of degrees as the highest level of mathematics one studies in high school. This is a very critical equity issue because not all high schools can offer their students the opportunity to learn the higher levels of mathematics that propel people to degrees—no matter what their eventual major field of study... And the precise point at which opportunity to learn makes the greatest difference in long-term degree completion occurs at the first step *beyond* Algebra 2, whether trigonometry or pre-calculus.[18]

Adelman's follow-up study both confirmed the key role of high school math beyond algebra 2 as dramatically increasing the odds of baccalaureate completion, and also underscored the diminished opportunity African American and Latino students have for such courses: they are significantly less likely than white and Asian students to be attending a high school that offered either calculus, trigonometry or statistics.[19]

If high school mathematics beyond algebra 2 correlates so strongly to baccalaureate completion for all majors, it is even more critical in STEM majors, where failing to enter college at least calculus-ready makes timely degree completion much more difficult. And the continuing disparity in high school mathematics opportunity for students of color and low SES continues to limit the pool of potential STEM majors.

Similarly, a strong lab-based science curriculum is essential for college-readiness and maintained STEM interest. Adelman also includes "more than 2.0 Carnegie Units of core laboratory science (biology, chemistry, and physics)" as well as "1.0 or more Carnegie Units of computer science" in the highest level of a scale describing academic intensity.[20] Again, while this intensity of curriculum is important for baccalaureate degree completion in any major, it is clearly more important for STEM majors. And again minority students are less likely to be enrolled in high schools that offer a full range of laboratory sciences.

As outlined below,[21] funding disparities across school districts tend to mean Latino students have more teachers in their first years of teaching and more who are teaching outside their field. This is especially true in STEM courses.

There have been a number of programmatic efforts to address these disparities. The Texas Prefreshman Engineering Program,[22] for example, has a track record since 1979 of providing high school students a rigorous science and math curriculum over the course of their four summers with documented results in college-going and completion rates. While these are not substitutes for systemic change that will enhance STEM opportunity for all students, they represent promising program models to address the immediate crisis in underrepresentation. Such programs illustrate the importance of serious instruction in math, lab science, and computer science; the value of a college setting (and a college faculty) to accustom students to higher education; and the need to track students throughout the school year. They also offer additional opportunities for informal science experiences and for partnerships with other STEM industries.

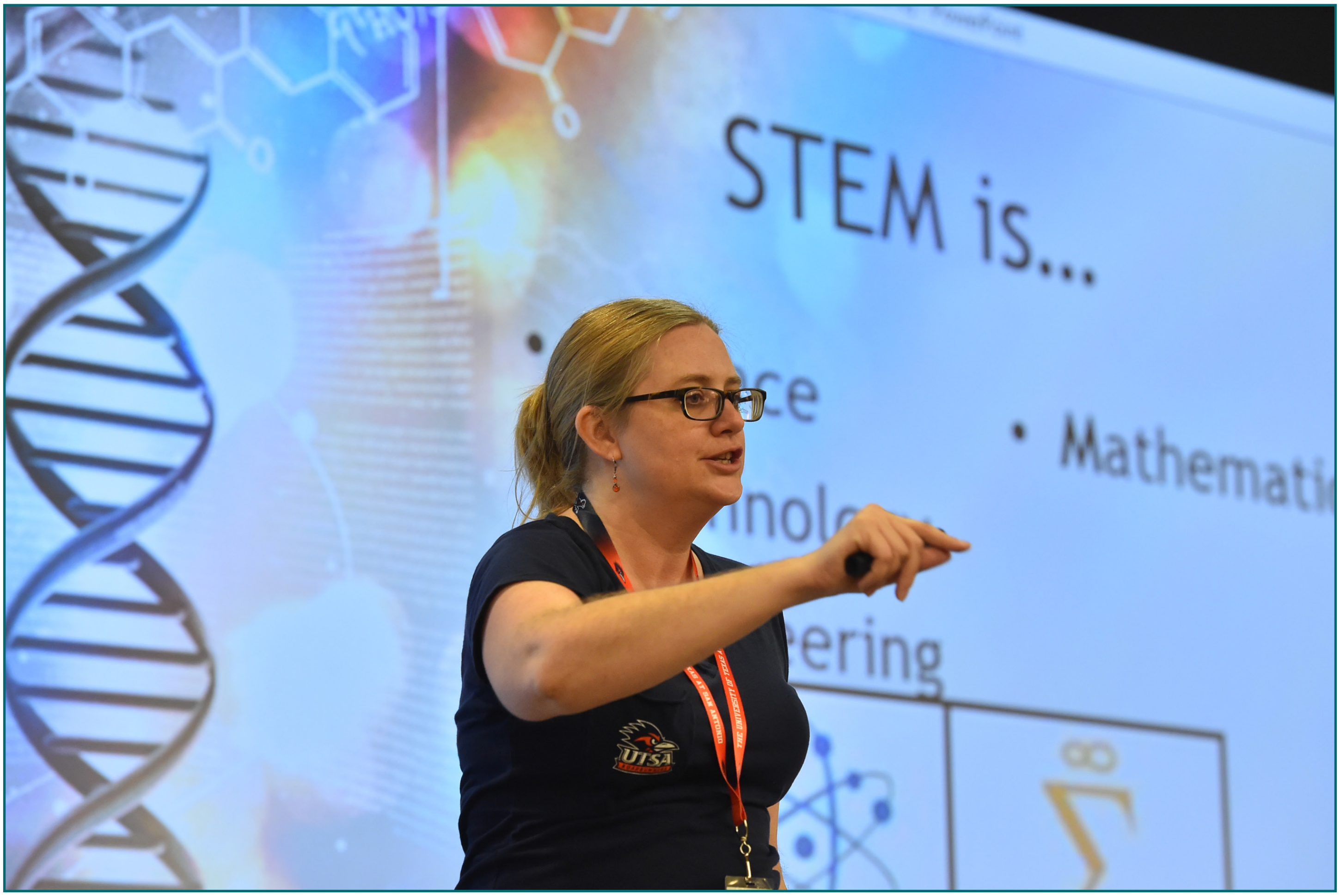
Advanced Placement and early college programs are likewise valuable to help students become more college-ready. Racial/ethnic and economic disparities impact the availability of AP courses, but a growing number of low-income school districts are finding higher education partners for early college programs. Early college also provides exposure to higher education faculty, expectations and settings and strongly supports some of the extra-curricular dimensions of college readiness.

Since not every STEM worker will be a research scientist and the field is also in need of a diversified technical workforce as well, high schools should be mindful of educational opportunities in technology, being careful to avoid rigidly tracking students into tech courses just because of demographic factors.

Finally, high schools can also facilitate work experiences that can include formal and informal science visits and field trips, internships, summer or part-time jobs in STEM fields. These opportunities can not only support the aspirations and formation of future scientists and technicians, but engage industry, nonprofit organizations and higher education institutions in on-going collaborations.

Policy Recommendation:
Every high school should be equipped to offer a mathematics curriculum beyond Algebra 2, the core laboratory sciences, and computer science, taught by experienced and qualified teachers. Academic and college counseling should also be available to every student. Advanced Placement should be an option in all schools, and early college programs should be fostered.

Practice Recommendation:
Precollegiate summer or after-hours programs in STEM fields can be important supplements to high quality STEM teaching and counseling and provide opportunities for partnerships that can ease the transition to higher education and provide realistic STEM career preparation.



18 Clifford Adelman, "Answers in the Toolbox," 1999, U.S. Department of Education, p. 16.

19 Clifford Adelman, "The Toolbox Revisited," 2006, U.S. Department of Education, pp. 31-33, https://www2.ed.gov/rschstat/research/pubs/toolboxrevisit/toolbox.pdf.

20 Ibid., p. xviii and p. 27.

21 See p. 13.

22 See https://future.utsa.edu/prep/prep/##contact.

COMMUNITY COLLEGE AND UNIVERSITY

As is clear from the above discussions, colleges and universities have roles to play in pre-collegiate education that extend beyond recruitment efforts. Active collaborations with PK-12 districts that serve as feeder systems are important in assuring that early interventions reduce barriers (informational, financial, cultural, academic, aspirational) that can prevent Hispanic students from considering higher education or STEM as real possibilities.

Moreover, given the fact that half of Hispanic undergraduate students are enrolled in community colleges,[23] building strong articulation agreements (and practices) is essential to moving the needle on baccalaureate STEM degree completion (and ultimately graduate STEM degree completion). Strong articulation in the STEM context should include significant STEM faculty interaction between two- and four-year institutions not only to facilitate credit transfer but to support stronger laboratory and research experiences for both community college students and community college faculty.

In addition to their concentration in community colleges for reasons of finance, geography, and ease of admission, Hispanic students are also concentrated in the nation's 523 Hispanic-Serving Institutions (HSIs), which enrolled 66 percent of Hispanic college undergraduates in 2017. Targeting resources to these institutions is the single most efficient and effective way to impact Hispanic participation in STEM disciplines, since these are the institutions where Hispanic students can be found in large numbers. Several federal programs (Title V, Part A, Developing Hispanic-Serving Institutions Program and Title V, Part B, Promoting Postbaccalaureate Opportunities for Hispanic Americans under the U.S. Department of Education, Title VII Hispanic-Serving Institution Grant Program in the U.S. Department of Agriculture, and the relatively new Hispanic-Serving Institutions Grant Program at the National Science Foundation) are first steps to addressing this resource question, although as of 2010, HSIs continued to lag other institutions in per student federal funding by over 30 percent.[24]

HSIs are pivotal in several areas. Divided roughly evenly between two- and four-year institutions, they are key partners in articulations that move Hispanic students through community colleges into baccalaureate programs. The baccalaureate HSIs have strong pools of Hispanic STEM undergraduates for graduate program recruitment. Many HSIs have teacher education programs and are sources of Hispanic PK-12 teachers, including the much-needed Hispanic math and science teachers. Few HSIs are strong research institutions (although that number is growing as several regional public institutions are moving toward stronger research commitments and more flagship institutions, especially in California and Texas, are reaching HSI status), but many have significant STEM graduate programs at least at the master's degree level. Indeed, it is hard to imagine making a significant impact on increasing Hispanic participation in STEM without HSIs playing a central role.

Undergraduate research experience is a "well documented" "positive influence" on minority students.[25] It is key that baccalaureate institutions with substantial numbers of Hispanic students have the ability to offer them serious STEM research opportunities. Programs and partnerships that allow students and faculty at HSIs to participate in world-class research, e.g. summer research opportunities at national laboratories, can play a critical role. Similarly, the Broadening Impact criterion of NSF funding can more explicitly motivate active collaborations between research universities and HSIs where much larger pools of Hispanic STEM undergraduates can be found. It is important that these collaborations be carefully designed to assure a balance of opportunity and contribution between institutions and to avoid a colonialism whereby the richer, more prestigious institution benefits from the more diverse talent pool and the HSI partner receives nothing. HSIs often have rich experience in building inclusive campus environments and reducing barriers experienced by first generation, low income, minority students that more research-oriented institutions could learn from.

Internships in STEM industries can likewise play an important role in supplementing the instruction and laboratory experience of Hispanic STEM students. There is no substitute for the real-life work experience an internship can provide for introducing students (especially first-generation students) to the culture of STEM work. Expectations taken for granted by recruiters, even the most obvious matters of professional dress and comportment, résumé format and interviewing skills, may not be so obvious to students whose only direct previous exposure to professionals is their family doctor and their teachers. Internships can help to bridge this potential experience and culture gap as well as provide a realistic exposure to what working scientists and technicians do every day. For low-income students, unpaid internships are *de facto* inaccessible: even college credit does not compensate for the opportunity cost of some months of earning power critical to financing education and living costs.

As mentioned in passing, HSIs are also the most important source of Hispanic PK-12 STEM teachers. Hispanics comprise only 8.8 percent[26] of the teacher workforce in 2015-16 while they were 25.9 percent of the public elementary and secondary student enrollment.[27] While one can certainly learn from teachers of a different race, ethnicity, class and gender, having adequate role models is also an important factor in supporting aspirations to STEM careers. HSIs are the obvious place to target efforts to increase the number of well-prepared Hispanic STEM teachers for our nation's children.

Policy Recommendation:

Among the many policy recommendations that could be made, the single most important one to the participation of Hispanics in STEM education is increasing funding support to Hispanic-Serving Institutions. Targeting those institutions where Hispanics are enrolled in large numbers with support for effective articulation programs, stronger laboratory STEM classes, enhanced STEM faculty research opportunities, more and more effective collaborations with research institutions (both universities and laboratories) is critical.

Practice Recommendation:

Expanding undergraduate research opportunities for Hispanic STEM students at HSIs is necessary. To do this will require more active collaboration from other institutions, research universities, national laboratories, non-profit and for-profit corporations that depend on research and development for their livelihood. It can (and probably must) take a number of forms: collaborative research grants, summer research and internship experiences for students, summer and collaborative research opportunities for HSI STEM faculty, cooperative education programs, etc.

23 HACU analysis of 2017-18 enrollments from the U.S. Department of Education, Integrated Postsecondary Education Data System (IPEDS).

24 HACU analysis of 2010-11 IPEDS.

25 Gloria Crisp and Amaury Nora, "Overview of Hispanics in Science, Mathematics, Engineering and Technology (STEM): K-16 Representation, Preparation and Participation," 2012, p. 10, http://www.hacu.net/images/hacu/OPAI/H3ERC/2012_papers/Crisp%20nora%20-%20hispanics%20in%20stem%20-%20updated%202012.pdf.

26 NCES, Digest of Educational Statistics 2017, Table 209.10. Number and percentage distribution of teachers in public and private elementary and secondary schools, by selected teacher characteristics: Selected years, 1987-88 through 2015-16, https://nces.ed.gov/programs/digest/d17/tables/dt17_209.10.asp.

27 Op. cit., Table 203.60. Enrollment and percentage distribution of enrollment in public elementary and secondary schools, by race/ethnicity and level of education: Fall 1999 through fall 2027, https://nces.ed.gov/programs/digest/d17/tables/dt17_203.60.asp.

GRADUATE STEM EDUCATION

At the upper end of the STEM job spectrum lie careers that demand graduate degrees, especially doctoral degrees, in STEM fields. While only a few Hispanic-Serving Institutions directly produce STEM PhDs, they are an essential preliminary step; HSIs account for 18 of the top 50 baccalaureate institutions for eventual science and engineering doctorate recipients.[28] This number reflects the much larger pool of Hispanic students at HSIs (and conversely the relatively low numbers of Hispanics at research intensive institutions) and also the quality of talent of this pool of students. HSI undergraduate STEM programs can be strong feeders of more diverse candidates for graduate and doctoral programs.

Collaborations mentioned above around undergraduate research, internship and work opportunities would foster stronger recruitment of more diverse talented graduate students. Assuming similar financial and geographic constraints apply to graduate institution choice as for undergraduate institutions (almost certainly the case for low income students unless the graduate institution can offer a generous fellowship), regional collaborations are more likely facilitate successful graduate program recruitment.

Adjustment to the very different environment and culture of graduate school is an issue for all students, but poses additional challenges for Hispanics and other underrepresented minorities (URMs). Figueroa and Hurtado[29] draw six conclusions from their research:

1. Many graduate programs are not sufficiently structured in a way "that clearly outlines class sequences and expectations for research productivity, at least in the first two years of graduate school."[30]
2. There needs to be adequate guidance from faculty advisors.
3. "(E)arly faculty support and mentoring is key for all students groups - whether the students are racial minorities or not and irrespective of discipline."[31]
4. Quality of teaching, especially enthusiasm for the subject and concern that students are actually learning, is critical to the students in the study.
5. Peer interaction is important in mitigating the solitary nature of much graduate study.
6. Racial issues are a common concern for URMs: "For URM STEM students to feel welcomed by their pragmatic community was to know that faculty cared about the diversity present within the program and made an effort to improve it, and cared about linking the implications of course concepts and research to racial/ethnic minority communities. These actions signaled to URM STEM students that they mattered to their programs."[32]

This study's conclusions point to recommendations that would improve the graduate school experience for all students, but have particular significance for Hispanics and other URMs. For example, while graduate school, especially in the first year, involves an element of loneliness for all students, it is particularly acute for Hispanic students who may be alone or one of only a handful of Latino/as in their departments. Finding a group of peers for social as well as professional support, finding a faculty advisor who will take the time to help with the academic and non-academic adjustments to graduate student life, and finding a departmental environment that is welcoming to (or at least neutral to) diversity are universal issues that have a disproportionate impact on URMs, especially if there are contrary messages that one doesn't belong or deserve to be in the program.

The conclusions of the Figueroa and Hurtado study are mirrored in the findings released recently by the Council of Graduate Schools from the Doctoral Initiative on Minority Attrition and Completion:

> The study also explored institutional practices that can help support underrepresented minorities working to complete STEM doctoral programs. Data sources shed light on the value of four particular elements: 1) conducting interventions throughout the entire doctoral process; 2) providing students with enhanced academic support; 3) monitoring and evaluating programs and interventions; and 4) cultivating a culture of diversity and inclusion.[33]

In the announcement, CGS President Suzanne Ortega noted that "the dissertation phase is a particularly critical time for students."

Several of the issues outlined above suggest that program leadership plays a critical role, i.e. is there a commitment to diversity, not only among the students accepted but among the faculty hired? Is there a commitment to student-learning-centered teaching? Are there policies and protocols to assure competent advising and mentoring for all students? For other issues, like peer interaction, leadership and faculty have less direct policy and practice impact, but can monitor and address in advising and mentoring conversations. The composition of and interaction within study groups and lab teams are other avenues to be considered in the realm of peer interaction. As Figueroa and Hurtado put it most succinctly:

> Although special programs and initiatives affect skill development for a small set of participants (i.e. workshops offered through student services, writing /graduate centers, programs targeting URMs) and make the graduate environment a more positive place to learn and grow, Departments and Deans must also shoulder more of the responsibility of improving teaching, training, and degree progress at the graduate level so as to reach a larger audience of students.[34]

Finally, in many fields, postdoctoral opportunities have become increasingly important and need to be on the advising/mentoring agenda at appropriate stages. Students not familiar with the processes involved will obviously benefit most from attention to this transition from STEM student to STEM professional.

Policy Recommendation:
The most important policy issues in graduate education seem to reside at the school, department and program levels as suggested above: a genuine commitment to diversity, a clear and faculty-supported curricular structure, a commitment to student learning and to competent and consistent advising and mentoring. Including Hispanic-Serving Institutions in the student recruitment pool ought to be a matter of building collaborations among equals rather than occasional raids in search of top talent. Institutions like NSF and NIH that are significant funders of university research can be more intentional about increasing diversity in the professions as a grant requirement.

Practice Recommendation:
Creating an environment of inclusion that offers both support and challenge may be the single most important practice for improving graduate degree completion of Hispanics. This intentionality must be expressed not only in the diversity of student recruitment efforts, but in faculty hiring and orientation, in positive steps to welcome, orient, advise and mentor all students, even in curricular inclusion of topics of special relevance to URMs.

28 National Science Foundation, Women, Minorities, and Persons with Disabilities in Science and Engineering 2015, Table 7-14. Top baccalaureate institutions of Hispanic S&E doctorate recipients: 2008–12, see link at http://www.nsf.gov/statistics/2015/nsf15311/tables.cfm.

29 Tanya Figueroa & Sylvia Hurtado, "Adjustment to the Graduate Environment: A Focus on URM Students in STEM," November 2014, http://www.heri.ucla.edu/nih/downloads/ASHE2014-Adjustment-to-the-Graduate-Environment.pdf.

30 Ibid., p. 32.

31 Ibid.

32 Ibid., pp. 33-34.

33 Council of Graduate Schools, CGS Report Highlights Completion Trends of Underrepresented Minorities in STEM Doctoral Programs, April 2015, http://cgsnet.org/sites/default/files/PR_DIMAC_2015-04-06_final.pdf. Unfortunately, the body of the report is only available to CGS members.

34 Figueroa and Hurtado, op. cit., p. 34.

STEM WORKFORCE

Increasing participation of Hispanics in the STEM workforce does not solely depend on producing more Hispanic STEM PhDs. As noted near the outset, the STEM workforce is itself a large tent, including many STEM fields, many levels of STEM employment with correspondingly different levels of education required.

One persistent form of pushback to recommendations to hire more Hispanics is the complaint that no qualified candidates can be found. (The same complaint can be heard at times in reference to graduate program admissions.) Given the concentration of Hispanic college students at HSIs, the complaint sounds somewhat disingenuous. If you can't find the fish where you're fishing, maybe you're fishing in the wrong place. Resources such as "Finding your Workforce: Latinos in Science, Technology, Engineering, and Math (STEM)"[35] produced by *Excelencia* in Education are designed to directly address this issue. This is not to say that there may not be some challenges relative to geography and specific subfields, for example. But for the larger STEM employers who work and recruit not only nationally but globally, these should not be insurmountable challenges if there is a genuine commitment to diversity.

Finding Hispanic job applicants who understand the corporate culture of a STEM workplace may be another challenge. For students with backgrounds that offered little exposure to professional careers, the soft skills assumed of successful employees may be foreign. Undergraduate and graduate programs in STEM can help to address some of these corporate cultural expectations, as business schools in some areas have begun to do. Likewise, employers genuinely committed to a diverse workforce can also recognize this issue and do more to respond to it. Early interventions and actual experience in STEM careers, e.g. through internships, are some avenues to a solution.

Realistically, the pressure STEM corporations experience to control expenses will always be at odds with practices that promote greater diversity. The reason Fortune 100 companies limit their recruiting to selective institutions, even when they know there are larger pools of Hispanics elsewhere, is that it's cost effective: they can count on high quality graduates with the least expenditure of recruitment dollars. Sadly, they will not find Hispanic candidates at those institutions in large numbers. Until there are countervailing pressures demanding a more diverse workforce, we will continue to see situations like premier Silicon Valley companies in a state that is 37 percent Hispanic unable to get into double figures of Hispanic employment.

Where might these countervailing pressures come from? Probably not from the moral and ethical arguments in favor of diversity. A more scientific approach is the growing body of research suggesting that diverse research teams are more innovative and more creative.[36] To maintain levels of innovation demanded by competition, market expectations, and new technological opportunities, successful companies will need diversity in order to be competitive. We may yet be some decades before that view becomes the received wisdom and by that time the demographic growth of U.S. Hispanics may have created its own pressure for diversifying the STEM workforce, but the early adopters should gain a competitive advantage in the interim.

Policy Recommendation:
Federal agencies in charge of advancing STEM education and related workforce should invest in capacity building of institutions enrolling the majority of underserved populations in STEM fields and stimulate the private sector to do the same in a coordinated and consistent basis.

Practice Recommendation:
Corporate commitments to diversity must be made for strategic reasons, and communicated with metrics and a reward system throughout the company. A vice president of diversity can be a helpful clearinghouse in maintaining data, measuring progress, and promoting promising practices, but it's the hiring managers who are the key in making companies more diverse. Their understanding and support of the corporate commitment is essential to progress in this area.

35 Deborah A. Santiago, Morgan Taylor, Emily Calderón Galdeano, "Finding your Workforce: Latinos in Science, Technology, Engineering, and Math (STEM)," June 2015, http://www.edexcelencia.org/research/workforce/stem.

36 See, for example, Scott Page, Diversity Powers Innovation, 2007, http://inclusive.nku.edu/content/dam/Inclusive/docs/diversity_powers_innovation.scot%20page.pdf; or Gerben S. Van der Vegt and Onne Janssen, Joint Impact of Interdependence and Group Diversity on Innovation, 2003, abstract at http://jom.sagepub.com/content/29/5/729.short.

THE ELEPHANT IN THE ROOM: INEQUITIES IN SCHOOL FUNDING

Hispanics are disproportionately more likely to fall below Federal poverty lines. This presents not only an economic limitation to the families of the next generation of potential Hispanic STEM workers, but it has a direct impact on the quality of PK-12 education available to lower-income students and students of color. The Education Trust has tracked some of these school funding disparities for a number of years. The most recent report "Funding Gaps 2018"[37] found that nationally, the quartile of school districts with the most students living below the poverty line received $1000, or 7 percent, less per student from state and local sources than the quartile of districts with the smallest percentage of poor students. More shockingly, "districts serving the most students of color receive about $1800, or 12 percent, less per student than districts serving the fewest students of color." The good news is that this is a modest improvement over the 2015 findings. The Report notes that there are significant differences between states and more states have moved to a more progressive funding formula that provides more state support for less wealthy districts, recognizing that it costs more to educate a poor child than a wealthy one. Nevertheless, students of color are less likely to attend schools that offer algebra 2, more likely to be taught by novice teachers, out-of-field teachers, and less effective teachers.[38] As the Education Trust succinctly put it in 2015: "The results are devastating. Kids who come in a little behind, leave a lot behind."[39]

As a result, young people from high income families are seven times more likely to earn a bachelor's degree by age 24 than those from low income families.[40]

Clearly, dramatic progress in increasing Hispanic participation in STEM fields in higher education and in those occupations that require baccalaureate or higher degrees will require dramatic changes in PK-12 educational policy, beginning with assuring equity in funding, teacher preparation and quality, availability of demanding STEM coursework across all school districts and all schools. Thirty percent of Latino children are not only children of color but low income and consequently likely to be lost to the pool of potential STEM workers before graduating from high school.

Policy Recommendation:
It is urgent that the nation and the individual states address the inequity of public school funding in PK-12 to assure that every child has equal opportunity to learn from the best teachers, have the most up-to-date resources, benefit from a strong lab-based science curriculum and a strong math curriculum especially in middle school and high school, and have exposure to extra-curricular activities and appropriate role models that would encourage and support an interest in STEM.

Practice Recommendation:
Other potential partners (other levels of educational institutions, STEM industries, relevant non-profits, local government agencies with STEM expertise) should target the poorest schools and districts and those with the highest concentrations of Hispanic students to provide volunteer resources that can fill in the gap until funding equity is achieved. These resources can range from providing career day speakers, visits to research or manufacturing lab facilities, partnering to support STEM advanced placement courses, etc.

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37 Ivy Morgan and Ary Amerikaner, Funding Gaps 2018, Education Trust, at https://edtrust.org/wp-content/uploads/2014/09/FundingGapReport_2018_FINAL.pdf.

38 The Education Trust, "Achievement and Opportunity in America," December 2015, https://edtrust.org/wp-content/uploads/2014/09/ga.atlanta.leadershipatlanta.pdf, see especially slides 62, 64, 65, and 67.

39 Ibid., slide 68.

40 Ibid., slide 73. But see also Matthew M. Chingos and Susan M. Dynarski, "How can we track trends in educational attainment by parental income? Hint: not with the Current Population Survey," March 12, 2015, http://www.brookings.edu/research/papers/2015/03/12-chalkboard-income-education-attainment-chingos, where in note 4 the authors estimate the baccalaureate completion advantage of the top economic quartile at only 3 times the bottom quartile.

LEADERSHIP, MENTORSHIP AND ROLE MODELS

From all that has been said above, there are some themes that emerge as critical for making significant progress in Hispanic inclusion in STEM. One of these is the role of leadership. State legislators, for example, need to find strategies past the political roadblocks to equitable school funding and to assure adequate funding for state higher education institutions, including student financial aid. The U.S. Congress should take up the goal of appropriating equitable federal funding for HSIs relative to other institutions of higher education and funding federal student aid programs to meet a reasonable share of student financial need.

Throughout the education system, from Pre-K through doctoral programs, educational leadership needs to be committed not only to the notions of inclusion and student success but also to the practical steps these goals will require. Superintendents and principals in PK-12 need to assure that all children in their charge have the opportunities to learn and succeed. Individual teachers make the difference in the classroom, but school and district leadership create the environment and either facilitates or undermines by policy and practice the efforts to make student learning central.

In higher education, college and university presidents also set the tone. Within the maze of competing interests, they can give more or less priority to student diversity. In their interaction with the academic administration and faculty, they can give more or less priority to student learning and to a balance between teaching and research. Presidents will drive collaborations with other institutions like their surrounding PreK-12 districts, their regional higher education neighbors, including their potential articulation partners, both two-year/four-year and baccalaureate/graduate programs. Involved as they are in development efforts, they often have the corporate contacts to promote essential partnerships with local and regional industry that can lead to internships and jobs for graduates, corporate participation in PreK-12 outreach efforts and undergraduate research, etc.

At the graduate level, power shifts increasingly to deans and program directors or chairs in terms of the concrete steps toward recruiting a diverse student body and building a climate of student success and learning. STEM deans and graduate program directors are also likely to have the professional contacts to involve corporate and government STEM employers in student career development.

Regarding STEM employers, the commitment to diversity also comes from the top and the CEO sets the tone for the organization and holds subordinates responsible for meeting goals. As mentioned above, there is a role for chief diversity officers as well, but much of the front-line responsibility for diversifying the STEM work force lies with the hiring managers themselves. Sometimes this may be a Human Resources function; sometimes distributed to various subdivisions of the corporation.

The need for and the importance of role models and of mentorship has been stressed at every stage. STEM professionals in university, corporate and government settings can have a powerful impact on students who may have no idea of the career possibilities in these fields, much less the steps required to achieve them. Hispanic role models in STEM are particularly important in demonstrating that these careers are open to those “who look like me.” Hispanic college students returning to their elementary and secondary schools can be tremendous examples of what can be next for the students now sitting in their desks.

Mentoring goes beyond role modeling in providing more concrete direction about the paths one needs to take to arrive at a STEM career. As early as middle school, counseling and advising are important in putting students on the right track academically and keeping them moving forward. But advising in college selection, and later in graduate school selection and application, and later still in post-doc or career selection is especially needed at these critical moments to keep students progressing toward their goals. Even students from backgrounds that provide more cultural capital in the form of parental education, wider exposure to educational opportunities and careers, and more direct STEM experience need advising and mentoring at these junctures to advance, so it should not be surprising that first generation and low income students should have the same need (and be less sure about how to meet it).

INFRASTRUCTURE DEVELOPMENT

Implicit in earlier discussions of funding inequities is the infrastructure need in those portions of the educational pipeline Hispanic STEM students are more likely to traverse. In addition to the greater likelihood of having inexperienced and out of field teachers in K-12 and of not having higher level math classes available, Hispanic students in poorer school districts will also lack the resources for laboratory sciences.

At the college and university level the underfunding of HSIs suggests a similar disparity in STEM infrastructure, especially in regard to undergraduate research opportunities. At “teaching” universities, lab space is necessarily dedicated to instructional purposes with far more limited opportunities for student and even faculty original research. Repeating classic “labs” is an essential element of pedagogy, but it’s a far cry from genuine laboratory research.

While more adequate funding would assure that the laboratory sciences at HSIs have a carefully selected and up-to-date set of resources for instructional purposes and perhaps some additional laboratory space to support original faculty research, teaching loads often preclude serious research on the part of faculty during the school year. Summer opportunities and collaborations with faculty and researchers at institutions with more resources become especially important. Leveraging these connections for undergraduate research experiences seems an obvious positive byproduct.

In addition to federal support for these infrastructural development, corporate and private support is needed. Better resourced institutions are more likely to have stronger relationships with major potential donors and will ordinarily need to take the lead in these conversations. The benefit for them is a stronger pipeline to a more diverse pool of graduate students and the research benefits of more diverse teams of researchers. The benefits for the HSI should include enhanced research opportunities for their faculty and students and more successful STEM graduates.

CONCLUSION: THE URGENCY

At the beginning of this report it was noted that 74 percent of people entering this U.S. workforce this decade are Hispanics. In the decade of the 2020's that proportion will only increase, and that decade's Hispanic workforce is already in our schools in large and growing numbers. To fail to provide the best educational opportunities, especially the best STEM educational opportunities, is to abandon the nation to a cadre of workers underprepared for the jobs of the future and to increase our STEM dependence on the global labor market. Both of these are costly consequences, in both economic and social terms.

Because we are talking about the workforce that is already in the pipeline, there is an urgency to fixing the educational issues that are depriving us of this potential talent pool. We already are seeking work-arounds to meet the STEM workforce needs. If we fail to increase the STEM participation of the youngest and fastest-growing segment of our population, we risk endangering our STEM innovation and the economic development so dependent upon it.

School districts that enroll the vast majority of students underrepresented in STEM education and post-secondary institutions with similar enrollments are the proverbial backbone of America's STEM workforce. HSIs play a prominent role in their preparation and competitiveness for current and emerging STEM careers. As such, they need to be equitably supported by government and society to ensure the nation's competitiveness in our global economy.

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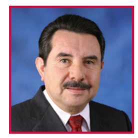

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ABOUT HACU

For over thirty years, the Hispanic Association of Colleges and Universities has advocated on behalf of Hispanic higher education in the U.S. and around the world. The mission of the Association is to Champion Hispanic Success in Higher Education.

HACU fulfills its mission by: promoting the development of member colleges and universities; improving access to and the quality of postsecondary educational opportunities for Hispanic students; and meeting the needs of business, industry and government through the development and sharing of resources, information and expertise.

HACU is the only organization that represents existing and emerging Hispanic-Serving Institutions (HSIs). HSIs today represent 15 percent of all institutions of higher education and enroll 66 percent of Hispanic undergraduates. HACU serves its membership through advocacy, conferences, partnerships and educational programs, and offers scholarships and internship opportunities for students.

HACU, is a nonprofit 501(c)(3) association with a membership of more than 500 colleges and universities in the United States, Puerto Rico, Latin America and Spain and school districts throughout the U.S. The Association's headquarters are located in San Antonio, Texas, with regional offices in Sacramento, California and Washington, D.C. Additional information is available at www.hacu.net.

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