NSF INCLUDES CONFERENCE

Advancing the Collective Impact of Retention and Continuation Strategies for **Hispanics and other Underrepresented Minorities in STEM Fields**

Washington, D.C.
March 6-8, 2017

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CAHSI Establishing a Networked Community for Broadening Participation of Hispanics in Graduate Studies

WELCOME

Welcome to the NSF INCLUDES Conference, Advancing the Collective Impact of Retention and Continuation Strategies for Hispanics and Other Underrepresented Minorities in STEM Fields!

We are pleased to be able to feature renowned scholars, academicians, practitioners, and individuals from the public and private sectors who have graciously agreed to share their expertise in broadening participation in STEM fields. Our expectation is that the panels will result in thought-provoking discussions among the experts and attendees that inform essential design features for collective impact. In addition, the panelists will make recommendations for successfully expanding educational and career pathways for Hispanics and other underrepresented minorities. Discussions will consider the barriers students confront, as well as the conditions under which successful initiatives can be enhanced through cross-sector collaborations and transferred to other contexts.

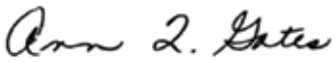
Thank you for joining us! Our hope is that you will expand your network and leave the conference with new ideas, actions, and partnerships that can propel your collective impact efforts forward.

Adelante!

Conference Planners



Marjorie S. Zatz
University of California, Merced



Ann Q. Gates
University of Texas El Paso



Deborah Santiago
Excelencia in Education



Saundra Johnson Austin
Charis Consulting Group LLC

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AGENDA

DAY 1: MONDAY, MARCH 6

Microsoft Innovation & Policy Center
901 K Street NW, 11th Floor
Washington, D.C. 20002

5:00 - 5:30 PM	**SHUTTLE FROM KELLOGG CONFERENCE HOTEL TO MICROSOFT INNOVATION & POLICY CENTER** *Meet in hotel lobby - shuttle runs continuously*
5:30 - 7:30 PM	**MICROSOFT INNOVATION & POLICY CENTER RECEPTION**
7:30 - 8:00 PM	**SHUTTLE FROM MICROSOFT INNOVATION & POLICY CENTER TO KELLOGG CONFERENCE CENTER HOTEL** *Shuttle runs continuously*

DAY 2: TUESDAY, MARCH 7

Kellogg Conference Hotel
800 Florida Avenue N.E.
Washington, D.C. 20002

7:00 - 8:00 AM *Ballroom Foyer*	**CONFERENCE REGISTRATION**
7:30 - 8:30 AM *Ballroom B & C*	**BREAKFAST**
8:30 - 8:45 AM *Ballroom B & C*	**WELCOME MESSAGE** Marjorie Zatz, University of California, Merced James Moore, III, NSF Program Director
8:45 - 9:00 AM *Ballroom B & C*	**CONFERENCE OVERVIEW** Ann Q. Gates, University of Texas at El Paso
9:00 - 9:30 AM *Ballroom B & C*	**KEYNOTE** Deborah Santiago, Excelencia in Education
9:30 - 9:45 AM *Ballroom Foyer*	**BREAK**
9:45 - 10:45 AM *Ballroom B & C*	**COLLECTIVE IMPACT: LESSONS LEARNED** Moderator: Sarita Brown, Excelencia in Education Panelists: Tanis Crosby, YWCA Silicon Valley Efrain Gutierrez, FSG/Cleveland Project Susan Johnson, Lumina Foundation

AGENDA

DAY 2: TUESDAY, MARCH 7 CONTINUED

10:45 - 11:45 AM
Ballroom A & D
DISCUSSION - COLLECTIVE IMPACT: LESSONS LEARNED

11:45 - 12:00 PM
Ballroom Foyer
BREAK

12:00 - 1:00 PM
Ballroom B & C
LUNCHEON

1:00 - 1:15 PM
Ballroom Foyer
BREAK

1:15 - 2:15 PM
Ballroom B & C
K-12 PIPELINE: FROM COMMUNITY TO CAMPUS
Moderator: Mary Fernandez, MentorNet/Great Minds in STEM
Panelists: Njema Frazier, Algebra by 7th Grade Chair, U.S. Department of Energy
Andrés Henríquez, New York Hall of Science
Saundra Johnson Austin, Charis Consulting Group

2:15 - 2:30 PM
Ballroom Foyer
BREAK

2:30 - 3:30 PM
Ballroom B & C
2 YEAR INSTITUTIONS: LATINO STUDENT SUCCESS IN STEM
Moderator: Elsa Villa, University of Texas at El Paso
Panelists: James Dorsey, Washington Mathematics, Engineering, Science Achievement (MESA)
Shirley Malcom, American Association for the Advancement of Science (AAAS)
Leticia Oseguera, Pennsylvania State University

3:30 - 3:45 PM
Ballroom Foyer
BREAK

3:45 - 4:45 PM
Ballroom B & C
UNDERGRADUATE DEGREES: INCREASING LATINO RETENTION AND COMPLETION
Moderator: Ann Q. Gates, University of Texas at El Paso
Panelists: Phillip Loya, Code 2040
Juan Meza, University of California, Merced
Heather Thiry, University of Colorado, Boulder

4:45 - 5:00 PM
Ballroom Foyer
BREAK

AGENDA

DAY 2: TUESDAY, MARCH 7 CONTINUED

5:00 - 6:00 PM
Ballroom A & D
DISCUSSION - K-12, 2-YEAR INSTITUTIONS AND UNDERGRADUATE DEGREES

6:15 - 8:15 PM
Atrium A
RECEPTION AT KELLOGG CONFERENCE HOTEL
Sponsored by Prudential

WEDNESDAY, MARCH 8

Kellogg Conference Hotel
800 Florida Avenue N.E.
Washington, D.C. 20002

7:00 - 8:00 AM
Ballroom B & C
BREAKFAST

8:00 - 8:15 AM
Ballroom B & C
WELCOME
Kamau Bobb, NSF Program Officer

8:15 - 9:15 AM
Ballroom B & C
GRADUATE DEGREES FROM RECRUITMENT TO COMPLETION FOR LATINOS IN STEM
Moderator: Antonia Franco, Society for Advancement of Chicanos & Native Americans in Science (SACNAS)
Panelists: Pauline Mosley, Pace University
Suzanne Ortega, Council of Graduate Schools
Marjorie S. Zatz, University of California, Merced

9:15 - 9:30 AM
Ballroom Foyer
BREAK

9:30 - 10:30 AM
Ballroom B & C
INDUSTRY PARTNERSHIPS: STRATEGIES FOR FINDING A DIVERSE WORKFORCE
Moderator: John D. Olivas, University of Texas at El Paso
Panelists: Eduardo Grado, Joseph Michaels International
Luis Rodriguez, International Business Machines
Travis York, Association of Public & Land-Grant Universities (APLU)

10:30 - 10:45 AM
Ballroom Foyer
BREAK

10:45 - 11:45 AM
Ballroom A & D
DISCUSSION - GRADUATE DEGREES AND INDUSTRY

11:45 - 12:45 PM
Ballroom B & C
LUNCHEON & WRAP-UP

SOCIAL MEDIA & PHOTOGRAPHY



Share your thoughts about the conference on social media using

#LatinxSTEM



Photo and audio releases will be distributed during the conference. If possible, please return your signed release to conference staff before the end of day on Tuesday, March 7.

If you are not comfortable signing a release, please let a conference organizer know.

PRESENTER INFORMATION



Ms. Sarita E. Brown is President of *Excelencia* in Education, a national not-for-profit organization dedicated to accelerating Latino success in higher education by linking research, policy, and practice to serve Latino students. She has spent more than three decades at prominent educational institutions and at the highest levels of government working to implement effective strategies to raise academic achievement and opportunity for low-income and minority students. She started her career at The University of Texas at Austin by building a national model promoting minority success in graduate education.

Coming to the nation's capital to work for educational associations, Ms. Brown served as Executive Director of the White House Initiative for Educational Excellence for Hispanic Americans under President Bill Clinton and U.S. Secretary of Education Richard Riley. She later applied her talents and experience to the not-for-profit sector and in 2004, co-founded *Excelencia* in Education in Washington, DC.

Her efforts have been recognized by many including, the Harold G. McGraw Jr. Prize in Education for "innovative thinking, strong leadership and accomplishment by example," the National Association of Student Personnel Administrators and the American Association of University Women. She has been awarded an Honorary Doctorate from North Carolina State University, Carlos Albizu University and the University of Saint Joseph. An advocate for educational equity, Ms. Brown currently serves on the Board of Directors for ACT, Inc., Editorial Projects in Education, Catch the Next and *Excelencia* in Education.

Mr. Andrés Henríquez is the Vice President of STEM in Learning Communities at the New York Hall of Science (NYSCI), where he is currently leading the Queens 20/20 initiative, a partnership between NYSCI and the local community. He previously worked as a program officer at both the National Science Foundation and the Carnegie Corporation of New York. He has also served as Assistant Director at the Center for Children and Technology (CCT) where he led a partnership between Bell Atlantic and the Union City, NJ Schools, a predominantly Latino, inner city community. Union City received national recognition when President Clinton and Vice President Gore acknowledged the extraordinary accomplishments of the school district, which ultimately became the model for a five-year, $2 billion program to put computers in all U.S. classrooms.



At Carnegie Corporation, Henríquez launched a national program of work focused around adolescent literacy and also funded and oversaw the development of the Next Generation Science Standards including the National Research Council's (NRC) Framework for K-12 Science Education, and the funding of Achieve Inc. to develop the framework-aligned Next Generation Science Standards and, finally funding the NRC to write the Developing Assessments for the Next Generation Science Standards. Through his work as a teacher, researcher, advocate, and funder, he has long been committed to making a difference in the lives of underserved children. He serves as a trustee for Hamilton College, is a board member of Excelencia in Education and on the Education Advisory Board of the National Park Service.



Ms. Tanis Crosby is a passionate non-profit leader, with a track record of transformational impact and growth. Before joining YWCA Silicon Valley, Tanis led YWCA Halifax for ten years. At YWCA Halifax, Tanis led the strategic and change management process to transform the agency to a dynamic organization, becoming the largest women's organization in Atlantic Canada. Achievements included quadrupling the operating budget, growing from one to twenty community based locations, merging with another non-profit organization, and completing four capital projects.

At YWCA Silicon Valley, she has led the agency to growth and impact, focusing efforts through collective impact and systems change to eliminate racism and empowering women. She Co-Chairs the Santa Clara County IPV Blue Ribbon Task Force, a Collective Impact process to end violence, and serves as the backbone agency for the Curated Pathways™ to Innovation program. YWCA Silicon Valley was named a 2016 California Non-Profit of the Year.

In recognition of her leadership, Tanis was awarded the Queen Elizabeth Golden Jubilee Medal by the Government of Canada and the YWCA Canada President's Award. In recognition of successfully advocating for a landmark public policy changes, she was honored with the Elizabeth Fry Housing Hero Award, with recognition from Canada Mortgage and Housing Corporation with the National Best Practice Award. A native of Vancouver British Columbia Tanis studied Politics at Queens University in Ontario, Non Profit Management at Dalhousie University in Nova Scotia, and now lives with her family in Morgan Hill, California.

Mr. James Dorsey has over 35 years of leading national, statewide, and campus-based Mathematics Engineering Science Achievement (MESA) programs with a focus on promoting historically underrepresented communities in to the STEM fields. He has extensive experience in developing and implementing the services, activities and enrichments that positively impact the retention of underrepresented students from K-16 education pathway.



In California and Washington, he has worked with the National Science Foundation (NSF) to replicate the MESA Community College Program (STEP) and the Louis Stokes Alliances for Minority Participation (LSAMP) program.

His expertise has led to multiple National Science Foundation grant awards, as well as drive system level partnerships with multinational industries, local municipalities, and private philanthropic organizations to develop curriculum and supplemental learning activities that improve educational outcomes for diverse student populations.

From California to Washington, programs that Mr. Dorsey has established have gone on to receive state funding due to the sustainable nature of his approach and recognized success in advancing underrepresented students throughout the STEM pipeline. Mr. Dorsey continues to develop and implement regional, statewide, and national partnerships with industry and government agencies to better serve MESA students throughout the educational pathway. He currently serves as the Executive Director Washington MESA and as President of MESA USA.



Dr. Antonia O. Franco serves as the Executive Director of SACNAS; a national nonprofit organization devoted to increasing diversity in the science, technology, engineering, and mathematics (STEM) fields. She leads a community of 20,000 students, scientists, and educators including 115 chapters nationwide in the movement to build a critical mass of diverse scientists with advanced degrees and in positions of leadership in STEM.

Dr. Franco's career has spanned nearly two decades in higher education and philanthropy working on issues of educational access, equity, and college completion in underrepresented communities. She also has extensive experience in developing educational and community based partnerships. Dr. Franco earned her Doctorate in Educational Administration and Supervision from the Mary Lou Fulton Teachers College of Education at Arizona State University.



Dr. Mary Fernández is President of MentorNet, a division of Great Minds in STEM. Great Minds in STEM is a national non-profit with a 28-year history of advancing STEM education in under-served communities. MentorNet is virtual mentoring service that provides the opportunity for all STEM students, in all U.S. states and in all levels of higher education, to have access to mentors who are professionals working in STEM fields. MentorNet's guided, one-to-one mentorships help students – especially women, under-represented minorities, and first-generation to college – to persist and succeed in their fields.

Since 1998, Mary has mentored 23 MentorNet mentees while she pursued a career in computing research. Before joining MentorNet, Mary had a 17-year career at AT&T Labs Research, as a research computer scientist specializing in database and information systems, then as the head of distributed computing research, and finally as assistant vice president of information and software systems research.



Dr. Njema Frazier is Co-founder and Chair of the Algebra by 7th Grade (Ab7G) Initiative – an educational math initiative to increase the number of underrepresented minority students with the prerequisites to pursue science, technology, engineering, and mathematics (STEM). She is also a member of the National Advisory Board of the National Society of Black Engineers (NSBE), and the Founder and Chief Executive Officer of Diversity Science, LLC, an expert-based network of scientists and engineers dedicated to broadening participation in STEM.

Dr. Frazier serves in these STEM education, advisory, and advocacy roles, while maintaining full time employment as the Acting Director of the Office of Inertial Confinement Fusion (ICF) for the US Department of Energy, National Nuclear Security Administration (NNSA), a federal program that provides experimental capabilities and scientific understanding for weapons-relevant high energy density physics (HEDP). Her federal career also includes previous roles as the Acting Deputy for the

Office of Advanced Simulation and Computing and Acting Director for the Office of International Programs Management within NNSA; three years as a Visiting Professor at the National Defense University, College of International Security Affairs, in Washington, DC; and four years as a Professional Staff Member for the U.S. House of Representatives, Committee on Science.

Dr. Frazier is the recipient of multiple career awards including the DOD Joint Civilian Service Commendation Award; the award for Distinguished Service to the National Nuclear Security Administration; and the Black Engineer of the Year (BEYA), Science Spectrum's Trailblazer Award. She has been featured on Careergirls, Diverse Faces of Science, the Grio's List of 100 History Makers in the Making, the Black Enterprise Hot List, the Essence Power List, and the EBONY Power 100 list. Under the Obama Administration, Dr. Frazier was named as a Champion for the Secretary of Energy's Minorities in Energy (MIE) Initiative and a Leadership Ambassador for the One DOE campaign to promote diversity and inclusion. Dr. Frazier is a theoretical nuclear physicist with a Masters and Ph.D. from Michigan State University and a BS from Carnegie Mellon University.



Mr. Eduardo "Eddie" Grado, Partner at Joseph Michaels International has over 30 years of recruiting experience in Higher Ed and with search firms. MIT educated (MIT, Bachelor of Science in Management, 1983) and former Associate Director of Admission at MIT and Caltech, Eddie served on 3 national scholarship committees. After very successful life in college recruitment, Eddie moved to the corporate world and has become successful in recruiting Technical, Sales, Manufacturing, Mortgage, Big 4, Diversity and LATAM professionals. Over the years, Eddie has built an impressive network of college relations/university networks and has helped develop and grow educational outreach programs. At MIT and Caltech, he assisted the fundraising and developments offices along with faculty to raise funds for their outreach programs at those universities. Eddie also was a Partner in a cross-border business and educational start-up venture between the Mexican Government, business and Microsoft. At a grassroots level, Eddie was the executive director for West Los Angeles's only bilingual and bicultural non-profit organization serving the Latino community.

More recently, Eddie joined many of his MIT recruits in starting the AVANZA Network. He is the vice president of recruiting for Avanza Network, a leadership and professional group founded by MIT alumni for the advancement of Mexican-American and underserved communities. At last year's annual conference in September, Grado and two dozen other Avanza members spoke with 1400 students at 14 Las Vegas high schools in two days. At the same event, Avanza honored Grado with its first lifetime achievement award.



Mr. Efrain Gutierrez is an Associate Director in FSG's Seattle office and brings experience and knowledge from work and research in evaluation, learning, strategic planning, and social justice. At FSG, Efrain has participated in strategy, evaluation and Collective Impact projects with a variety of national and regional foundations including the Lumina Foundation, The Grand Rapids Community Foundation, The California Endowment, and the Kresge Foundation.

At FSG, Efrain has helped philanthropic organizations design and implement

organization-wide and program specific evaluation strategies and has also evaluated place-based strategies in education, health, environment, economic development, among other areas. As part of his work, he also develops conference sessions, blog posts, and webinars that increase evaluators' cultural competency when working with the Latino and the LGBTQ+ communities. Efrain holds a MPA from the University of Washington and a B.A. with honors in International Business and Management from the Universidad Panamericana in Guadalajara, Mexico.



Dr. Susan D. Johnson is Director of Impact and Research at Lumina Foundation where she guides data-informed decisions in Lumina's efforts to achieve Goal 2025.

Throughout her career in higher education, she has acquired intimate knowledge of policies and practices affecting student success, student engagement, and institutional accountability. After joining Lumina in 2008, Susan served as a strategy officer and later as Director of Equity and Inclusion where she actively sought to engage professionals, scholars, and partners committed to the promotion of equity and excellence in postsecondary education.

Prior to joining Lumina, Susan held professional positions in student affairs at Louisiana State University and the University of North Dakota and in institutional research at Indiana University. Johnson earned her B.S., M.S., and M.Ed. degrees from the University of Florida and her Ph.D. in Higher Education and Student Affairs at Indiana University.

Susan is actively involved in the philanthropic sector, currently serving on the board of Grantmakers for Education (GFE) and the executive team of Indiana Blacks in Philanthropy (IBIP). She is also a co-editor of Standing on the Outside Looking In: Underrepresented Students' Experiences in Advanced Degree Programs.



Ms. Saundra Johnson Austin is the President and CEO of Charis (pronounced Kare'us) Consulting Group LLC founded in 2007. Previous leadership roles include senior vice president for operations at the National Action Council for Minorities in Engineering, Inc. (NACME), president and CEO of St. Michael's High School, executive vice president of the Community Partnership for Lifelong Learning (CPLL), executive director of the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM), and Minority Engineering Program director at The Pennsylvania State University. Ms. Johnson Austin began her career at Bechtel Power Corporation.

In 1998, she was recognized with the National Society of Black Engineers' Inaugural Golden Torch Award for Minority Engineering Program Director of the Year, and Outstanding Contribution by a Minority Engineering Program Administrator Award by the National Association of Multicultural Engineering Program Advocates (NAMEPA). She was awarded the 2004-2005 Selected Professions Fellowship by the American Association of University Women. In April 2016, she was recognized by

The Pennsylvania State University as Outstanding Engineering Alumnus for Civil and Environmental Engineering and she currently serves on the College of Engineering's Industrial and Professional Advisory Council and is a member of the U.S. White House endorsed initiative Algebra by 7th Grade.

She enjoys mentoring young girls, college students, and early professionals on the opportunities in STEM education and careers, and keynote speaker for middle school and STEM program graduations. She earned a Bachelor's degree in Civil Engineering from The Pennsylvania State University, a MBA from the University of Notre Dame, and is currently enrolled in the University of Southern California's Organization Change and Leadership doctoral program.



Mr. Phillip Loya is the Recruitment Manger for the Fellows Program and comes to CODE2040 from UC Berkeley's Incentive Awards Program, the largest privately funded recruitment, retention, scholarship, and degree completion program in the UC System. He conducted outreach and recruitment to primarily low-income, first-generation, underrepresented students at various high schools throughout California.

Growing up in Boyle Heights in East Los Angeles, Phillip has experienced the inequities within various underrepresented communities and has dedicated his life to helping those who need it most. Phillip was the first in his family to attend college, graduating from the University of California, Berkeley with a degree in Political Science. He is excited to continue his work at CODE2040 by helping Black and Latino/a students find success in the tech industry! Outside of work, Phillip enjoys hiking, running, and driving on long road trips.



Dr. Shirley Malcom is Head of Education and Human Resources Programs of the American Association for the Advancement of Science (AAAS). The directorate includes AAAS programs in education, activities for underrepresented groups, and public understanding of science and technology. Dr. Malcom was head of the AAAS Office of Opportunities in Science from 1979 to 1989. Between 1977 and 1979, she served as program officer in the Science Education Directorate of the National Science Foundation (NSF). Prior to this, she held the rank of assistant professor of biology, University of North Carolina, Wilmington, and for two years was a high school science teacher.

Dr. Malcom received her doctorate in ecology from The Pennsylvania State University; master's degree in zoology from the University of California, Los Angeles; and bachelor's degree with distinction in zoology from the University of Washington. In addition, she holds thirteen honorary degrees.

Dr. Malcom serves on several boards, including the Howard Heinz Endowment. She is an honorary trustee of the American Museum of Natural History, a Regent of Morgan State University, and a trustee of Caltech. She has chaired a number of national committees addressing education reform and access to scientific and technical education, careers and literacy. Dr. Malcom is a former trustee of the Carnegie Corporation of New York and a fellow of the AAAS and the American Academy of Arts and Sciences. In 2003, she received the Public Welfare Medal of the National Academy of Sciences, the highest award bestowed by the Academy.

Dr. Malcom was a member of the National Park System Advisory Board from 1999-2003. She served on the National Science Board, the policymaking body of the National Science Foundation from 1994 to 1998, and from 1994-2001 served on the President's Committee of Advisors on Science and Technology.



Dr. Juan Meza is Dean of the School of Natural Sciences at the University of California, Merced, having taken that position in September 2011. He also holds a position as Professor of Applied Mathematics. He has worked on various scientific and engineering applications including scalable methods for nanoscience, electric power grid reliability, molecular conformation problems, optimal design of chemical vapor deposition furnaces, and semiconductor device modeling. His current research interests include nonlinear optimization and high performance computing.

Prior to joining UC Merced, Dr. Meza held positions at Lawrence Berkeley National Laboratory where he served as Department Head and Senior Scientist for High Performance Computing Research and at Sandia National Laboratories where he held the position of Distinguished Member of the Technical Staff.

Dr. Meza received the 2013 Rice University Outstanding Engineering Alumni Award and was named to Hispanic Business magazine's Top 100 Influentials in the area of science. In addition, he was elected a Fellow of the AAAS and was the 2008 recipient of the Blackwell-Tapia Prize, and the SACNAS Distinguished Scientist Award. He was also a recipient of the 2008 ACM Gordon Bell Award for Algorithm Innovation.

Dr. Meza has served on numerous committees including the National Research Council Board on Mathematical Sciences and their Applications; DOE's Advanced Scientific Computing Advisory Committee; the AAAS Council; and served on the boards for SACNAS, SIAM, the Institute for Pure and Applied Mathematics, and the Institute for Mathematics and its Applications.



Dr. Pauline Mosley holds a Bachelor of Science in Math and a Bachelor of Science in Computer Science from Mercy College; a Master of Science in Information Systems and a Doctorate of Professional Studies from Pace University. She embarked upon a teaching career in 1986, working as a top corporate trainer for Personal Computer Learning Centers of America, Inc. where she trained Fortune 500 executives and personnel in a myriad of software applications. She developed computer training manuals for Texaco, Pepsi, The Port Authority and McCraw-Hill and was influential in establishing PC and mainframe user-support help desks for Dannon, NYNEX, and Brooklyn Union Gas.

Prior to joining Pace in 2000, she was a tenured CUNY faculty member for 10 years and an adjunct professor at the following colleges: Westchester Community College, Iona, The College of New Rochelle, and Mercy College. She is the recipient of Who's Who Among America's Teachers. She is an Associate Professor of Information Technology in the School of Computer Science and Information Systems at Pace University in Pleasantville and teaches primarily LEGO robotics, web design and ser-

Systems at Pace University in Pleasantville and teaches primarily LEGO robotics, web design and service-learning courses. Dr. Mosley's research interests include cognitive models for learning robotics and web development. She has explored pedagogical methodologies that explore the relationships between service-learning and learning and its impact long-term on students. She is a member of the Institute of Electrical and Electronic Engineers, Inc. (IEEE) and frequently serves on the program committee of national conferences in Information Technology. Journals in which her research has appeared include *The Journal of Computing Sciences in Colleges, International Journal of Across The Disciplines* and *The Academic Exchange Quarterly.*



Dr. John Daniel "Danny" Olivas and his wife, Marie, have 5 children. Both are UTEP graduates, where he received a Bachelor of Science degree in mechanical engineering in 1989. In 1993 he received a Master of Science degree in mechanical engineering from the University of Houston and then a doctorate in mechanical engineering and materials science from Rice University in 1996. After serving a program manager at the Jet Propulsion Laboratory, NASA selected Olivas as an astronaut mission specialist in 1998. He has flown on two space shuttle missions, STS-117 and STS-128 and performed a total of 5 space walks over nearly 28 days cumulative in space.

Dr.Olivas retired from NASA in 2010 and became Director of Engineering at Raytheon Space and Airborne Systems. In 2013 Olivas incorporated Olivas & Associates and joined the University of Texas at El Paso as Director of the Center for the Advancement of Space Safety and Mission Assurance Research (CASSMAR). Both in practice and academia, Olivas strives to bring the lessons learned in space surrounding mission assurance to private, public and government institutions to aid in identifying, analyzing and mitigating risk of engineered products and operational processes.



Dr. Suzanne Ortega became the sixth President of the Council of Graduate Schools on July 1, 2014. Prior to assuming her current position, she served as the University of North Carolina Senior Vice President for Academic Affairs (2011-14). Previous appointments included the Executive Vice President and Provost at the University of New Mexico, Vice Provost and Graduate Dean at the University of Washington, and the University of Missouri. Dr. Ortega's masters and doctoral degrees in sociology were completed at Vanderbilt University.

With primary research interests in mental health epidemiology, health services, and race and ethnic relations, Dr. Ortega is the author or co-author of numerous journal articles, book chapters, and an introductory sociology text, now in its 8th edition. An award-winning teacher, Dr. Ortega has served review panels for NSF and NIH and has been the principal investigator or co-investigator on grants totaling more than six million in state and federal funds. Dr. Ortega serves or has served on a number of professional association boards and committees, including the Executive Boards of the Council of Graduate Schools, the Graduate Record Exam (GRE), the National Academies of Science Committee on the Assessment of the Research Doctorate, the National Science Foundation's Human Resources Expert Panel, the North Carolina E-learning Commission, the North Carolina Public School Forum, the UNC TV Foundation, and the UNC Press Board of Governors.



Dr. Leticia Oseguera is an Associate Professor in the Department of Education Policy Studies and a senior research associate at the Center for the Study of Higher Education at Pennsylvania State University. Her research focuses on college access and transitions of historically underserved populations and has been funded by foundations and local, state, and federal agencies. She is currently leading two STEM related evaluation projects, one funded by HHMI examining the adaptation of the Meyerhoff program at Penn State University and an NSF funded National Research Traineeship on Computational Materials Education and Training (CoMET).

In a former role, Dr. Oseguera was also a project director for an NIH funded study examining undergraduate research preparation in the biomedical and behavioral sciences. Her research has been published in *Journal of Women and Minorities in Science and Engineering*, *Youth and Society*, *Research in Higher Education*, *Review of Higher Education*, *Journal of College Student Retention*, and *Journal of Hispanic Higher Education.*



Dr. Ann Quiroz Gates is the Chair of the Computer Science Department at UTEP and past Associate Vice President of Research and Sponsored Projects. She directs the Cyber-ShARE Center of Excellence that focuses on interdisciplinary research and education. Her research areas are software property elicitation and specification, and semantic-enabled technologies. Dr. Gates leads the Computing Alliance for Hispanic-Serving Institutions (CAHSI), an NSF-funded consortium that is focused on the recruitment, retention, and advancement of Hispanics in computing, and is a founding member of the National Center for Women in Information Technology (NCWIT), a national network to advance participation of women in IT. Dr. Gates received the 2015 HENAAC Educator Award, the 2015 CRA A. Habermann Award, the 2010 Anita Borg Institute Social Impact Award and the 2009 Richard A. Tapia Achievement Award for Scientific Scholarship, Civic Science, and Diversifying Computing.



Dr. Luis H. Rodriguez is an Industry Ecosystem Development Director within Product Management in the IBM Watson IoT Division. In that role, Luis is creating a marketplace of Buildings IoT Solutions, and a Data Exchange around IBM's IoT for Buildings partner ecosystem. Luis previously served as the product management director and also as the business development director for IBM's asset management segment and real estate management segment. Luis' previous executive roles include the lead for IBM's 40+ Innovation Centers, and strategy leadership in the IT Service Management and the Collaboration Solutions division.

Prior to IBM, Luis was the COO and a co-founder of photo.net, a startup. Luis also served in consulting roles at McKinsey & Co. and in research roles at Xerox's Palo Alto Research Center. Luis attended the Massachusetts Institute of Technology, where he obtained Ph.D., S.M., and S.B. degrees in Computer Science.



Ms. Deborah A. Santiago is the co-founder, Chief Operating Officer and Vice President for Policy at *Excelencia* in Education. For more than 20 years, she has led research and policy efforts from the community to national and federal levels to improve educational opportunities and success for all students. She co-founded *Excelencia* in Education to inform policy and practice to accelerate Latino student success in higher education.

Ms. Santiago's current work focuses on federal and state policy, financial aid, Hispanic-Serving Institutions (HSIs), and effective institutional practices for student success in higher education. She has been cited in numerous publications for her work, including *The Economist*, the *New York Times*, the *Washington Post*, *AP*, and *The Chronicle of Higher Education*. Deborah serves on the board of the National Student Clearinghouse, and the advisory boards of thedream.us and Univision's Education Campaign.



Dr. Heather Thiry is a research faculty member at the University of Colorado, Boulder. She is an educational researcher and program evaluator specializing in STEM education innovation from the K-12 through graduate education levels. Her research and evaluation interests focus on the educational and career pathways of students from groups traditionally underrepresented in scientific and technological fields. For the past decade, she has been one of the external evaluators of the BPC Alliance, the Computing Alliance of Hispanic-Serving Institutions (CAHSI).

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Dr. Elsa Villa is Director of the Center for Education Research and Policy Studies in the College of Education at The University of Texas at El Paso (UTEP), and also a member of the proposal development team in the UTEP Office of Research and Sponsored Projects. Villa has led and co-led numerous STEM grants from corporate foundations and state and federal agencies. She recently led an NSF-funded grant entitled "Latinas in Computer Science and Engineering," which investigated identity and agency of undergraduate Latina students.

Currently, Villa leads an interdisciplinary project funded by the U.S. Department of Education to increase success of STEM majors in a gateway course leading to STEM degrees. With publications in various refereed journals and edited books, her research interests include communities of practice, gender, STEM teacher education, transformative learning, and identity.



Dr. Travis T. York is the Director of Student Success, Research & Policy at the Association of Public & Land-grant Universities (APLU). His research centers on issues of college student access, success, and educational equity. Dr. York's work has focused on examining pathways into and through postsecondary environments for low-income and first-generation students. Currently, Dr. York is the project coordinator and Co-PI of APLU's INCLUDES Project–a National Science Foundation funded effort to diversify STEM faculty; and serves as a Co-PI on the recently announced Department of Education, IES grant titled, *Affording Degree Completion: A Study of Completion Grants at Accessible Public Universities*.

Dr. York is also project coordinator of Project Degree Completion–a collaborative effort between APLU and AASCU in which nearly 500 institutions have committed to award an additional 3.8 million bachelor's degrees by 2025. Dr. York serves as the primary evaluator on APLU/USU's *The Collaboration of Change Project* funded by the Bill & Melinda Gates Foundation and the Kellogg Foundation funded *The Challenge of Change Project.*

Dr. York has author numerous peer-reviewed articles and book chapters, and is currently the lead editor of IAP's 2017-2018 volume *Advances in Service-Learning Research* series. Dr. York earned his B.A. and M.A. in Higher Education from Geneva College where he worked in Student Affairs, and his doctorate in Higher Education Administration from The Pennsylvania State University where he also served as the Editor of *Higher Education in Review* (2012-2013). Dr. York is active within several professional associations, serves on the editorial review board of J*ournal of Diversity in Higher Education*, as a reviewer for *College Student Affairs Journal* and the *Journal of International Research on Service Learning and Community Engagement*, and is a representative with several organizations including the Postsecondary Data Collaborative.



Dr. Marjorie S. Zatz is Vice Provost and Graduate Dean and Professor of Sociology at the University of California, Merced. She came to UC Merced in 2014 after 32 years at Arizona State University, where she was Professor of Justice and Social Inquiry in ASU's School of Social Transformation and served in a number of administrative capacities. Zatz was on leave from ASU in 2012-2014, serving as Director of the Law and Social Sciences Program at the National Science Foundation. Zatz has published seven books and more than 50 articles and chapters on immigration policy, race, gender and juvenile and criminal court processing, Chicano gangs, and the Cuban and Nicaraguan legal systems. Her recent books include *Dreams and Nightmares: Immigration Policy, Youth and Families* (University of California Press, 2015) and *Punishing Immigrants: Policy, Politics, and Injustice* (New York University Press, 2012).

Zatz is the recipient of numerous awards including the American Society of Criminology's Herbert Block Award, the American Society of Criminology Division on Women and Crime's Senior Scholar Award, the American Society of Criminology's Division on People of Color and Crime's Lifetime Achievement Award, and the Western Society of Criminology's W.E. B. DuBois Award for Research on Race and the Administration of the Administration and its Paul Tappan Award for Outstanding Contributions to Criminology. She received her Ph.D. in 1982 from Indiana University, Bloomington in sociology, with a minor in Latin American Studies.

Latinxs in STEM

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ABSTRACT

This comprehensive literature review covers best practices for institutions serving Latinxs in Science technology Engineering and Math (STEM) from K-12 to graduate school. Latinxs will account for 56% of the U.S. population by 2060 and remain underrepresented throughout educational pathways to careers in STEM. K-12 research has revealed the importance of exposing Latinxs to culturally relative pedagogies at this early stage, as well as drawing on the funds of knowledge that Latinx students already carry with them and applying them to STEM projects increasing engagement. Community college research illustrates the importance of culturally relative programming such as *PUENTE*, which supports Latinx students in their intentions to transfer to the 4-year institution with mentoring and positive peer communities. At the undergraduate level, the Ronald E. McNair Scholars program, which assists underrepresented minorities (URM's) interested in pursuing a Ph.D. with securing mentorship and research opportunities, have been shown to improve the trajectories of Latinxs in STEM. However, recruitment of Latinxs could be improved. At the graduate level, Latinx students are often faced with less than welcoming classroom climates as they navigate STEM programs that are white and male dominated. Researchers have recently begun to suggest finding ways to introduce critical race pedagogies in STEM graduate programs. More research is necessary to better understand how this can be achieved.

Keywords

Latinxs, STEM, Educational Pathways

1. INTRODUCTION

The need to move the needle on increasing Latinx representation in the STEM fields has become economically imperative to the future of the United States (U.S.). According to projections from the U.S. Census Bureau, underrepresented minorities (URM) will account for 56% of the U.S. population in 2060. (National Science Foundation, 2013). However, while people of color are projected to become the majority in the U.S. population (with Latinxs already having become the majority in California), they remain underrepresented in (STEM) Science Technology Engineering and Math (Annual Social and Economic Supplement Survey, 2015).

Latinxs are the most underrepresented group in all educational pathways leading to careers in STEM, from K-12 through graduate school (Santiago, Soliz & Excelencia in Education, 2012). As employers in these fields make efforts to diversify their workforce and remain competitive with other countries, they are faced with a dearth of domestic employees able to fill positions, particularly in engineering (Batarseh, Wood, Travis, & Turner, 2013; Camacho & Lord, 2011). Increasing the number of Latinxs entering careers in STEM would lead to more innovative ideas, as well as a workforce that understands and connects to a large portion of the U.S. population (Woerter, 2009).

Many argue that in order to create a well-paved pathway for Latinx students throughout education, changes need to be systemic (Bensimon & Dowd, 2012; Oseguear & Rhee, 2009; Solorzano, 2005). In order for systemic change to be envisioned, it is important to take a step back and look at the many pathways to STEM that Latinxs take, what is contributing to achievement, and what remains to be done in order to see many more Latinxs persisting during their educational trajectories as well as when they go on to careers in STEM. What follows is a comprehensive research review of K-12, Community College, Undergrad, and Graduate school research that has focused on Latinxs in STEM education. According to a report by the Advancement Project (2010), high stakes testing and zero tolerance policies in K-12 have increased what they refer to as

"pushout" of marginalized students, particularly URM's. For this reason, throughout the section on K-12, the use of dropout/pushout will be employed while discussing attrition in this sector of education.

2. K-12

According to a report released by the Pew Research Center in July 2016, Latinx dropout/pushout rates have decreased over the last decade. However, Latinxs are still the group with the highest dropout/pushout rates from high school at 12%, compared to Blacks 7%, Whites 5%, and Asians 1%. Strategies that value Latinx's lived experiences in K-12 include bilingual education, training teachers on how to implement culturally relative pedagogy, collaborating with families of students, and moving away from a deficit view of Latinx students (Gandara, 1995; Valenzuela, 1999; Castellanos, Gloria, Yamimura, 2006).

Studies on culturally relevant curricula exposure for Latinxs in K-12 reveal a positive effect on student's self-concept, sense of belonging in school, as well as GPA, graduation from high school, and matriculation into college (Rendon, 2003; Cabrera, 2014, Gandara, 1995; Valencia, 2011). In his study on the improvement that Mexican American Studies (MAS) courses had on low-income Latino students in Tucson Unified's High Schools, Cabrera found that although the MAS classes did not include math courses, the students who took MAS English and History courses saw improvements in their grades in math, reading, and writing (Cabrera, 2014). This may suggest that valuing the backgrounds of Latinx students and introducing them to critical race pedagogy as early as possible contributes to their incorporation into the classroom as leaders, increases self-efficacy, and provides a buffer against racialized micro-aggressions which improves academic achievement overall.

An anti-deficit approach to Latinx students in K-12 values the community cultural wealth that the students bring with them and results in achievement when it is combined with caring teachers that engage not only the students, but their families and communities as well (Valenzuela, 1999; Yosso, 2011). Studies have shown that there is an association between Youth Participatory Action Research (YPAR) in the humanities as well as STEM fields as early as high school (Gandara, 1995; Wilson-Lopez, Mejia, Hasbn, & Kasun, 2016; Cammarota & Romero, 2014). Wilson-Lopez et. al (2016) recently conducted a study on adolescents interested in STEM and applied a "funds of knowledge" grounded theory approach. Rather than describing STEM (specifically engineering in this case) as applied math and science, the Latinx research team informed the students that engineering could help "improve people's lives" (Wilson-Lopez et. al, 2016, 284). By asking students to imagine engineering projects that would improve their lives, the lives of their families or their communities, students aged 14-17 decided on a variety of projects including how to decrease the amount of bacteria that entered the milk at a dairy farm, how to create accessible entryways for the differently abled, and how to improve a local playground so that it would attract more community members (Wilson-Lopez et. al, 2016, 284). By drawing on these "funds" of community knowledge that Latinx students carry with them and applying engineering to their everyday lives, this intervention succeeded in engaging them in STEM.

Latinxs who matriculate into STEM undergraduate programs persist at the same rates as their white counterparts according to Lord (2006), so the primary issue lies in recruitment to STEM college programs while they are still in high school, rather than retention. Latinxs decide whether or not they will be entering a STEM discipline before college (Gandara, 2006), therefore, K-12 is a critical pathway to consider in the collaborative mission to increase Latinx participation in STEM. Ensuring they are exposed early and given the support they need through culturally relative/supportive peer groups, counseling, mentoring and financial aid (e.g., for SAT scholarships, college applications) throughout the K-12 years, these students have the capability of contributing to exciting new changes in the fields of Science, Technology, Engineering and Math (Rierson, 2006; de los Rios & Lopez, 2015; Cabrera, 2014; Rodriguez, 2014; Yosso; 2013; Sleeter, 2011; Gandara; 1995).

3. COMMUNITY COLLEGE

It has been well documented that community college is an entry point for many Latinxs who go on to higher education, and it has also been identified as a common entry point for Latinxs who go on to Ph.D. programs (Solorzano, 2005; Rivas, 2012; Castellanos et. al, 2006; Dimpal, Bernal, Solorzano, 2011). In a statistical analysis of the National Science Foundation's (NSF) National Survey of Recent College Graduates (NSRCG), Malcom (2011) found that 61% of Latinxs who had earned bachelor's degrees in STEM had attended a community college at some point in their educational trajectory. Malcom

also found that roughly 18% had earned associates degrees prior to transfer (2011). Excelencia in Education (2015) found that of all students earning degrees in STEM, Latinxs had higher completion levels at the certificate (18%) and associate (13%) levels than at the baccalaureate (9%), and represented only (3-4%) of completions at the graduate level. This may have something to do with what community college researchers have referred to as the "cooling out" of aspirations in community college (Brint & Karabel, 1989; Clark, 1982, 1980; Ornelas, 2002).

The factors contributing to "cool out" and eventually dropout/pushout of Latinx students, include frustrations over being saddled with remedial coursework (often due to poor preparation/counseling at the K-12 level), inaccessibility of institutional agents (as most Latinx students in community college work and take night classes after most offices are closed), time to degree, and an absence of "transfer culture"(Ornelas, 2002; Ornelas & Solorzano, 2004), which is an expectation by the institution that students will transfer and ongoing support of the students in that endeavor. One of the Excelencia's (2015) recommendations for increasing community college to 4-year transfers of Latinxs in STEM, was a Collective Impact project and partnerships between community colleges and 4-year universities for programs that support Latinx students interested in STEM.

Batarseh (2013) found that participants in their study had chosen community colleges because they were low cost and students could remain close to home. The factors that helped transfer from community colleges to engineering schools at the 4-year university included living at home with family, receiving support from passionate professors, a rigorous curriculum, completing internships, and joining campus clubs. Rendón (2003) highlighted the importance of pathway programs such as *Puente*, a community college based program that has served primarily Black and Latinx students since 1981, when it was piloted in Hayward, California. Since its inception, *Puente* has expanded to high schools and community colleges across the nation. What is unique about the program, according to Rendón (2003), is the validation that it provides underrepresented students by engaging them in rigorous reading and writing within a critical race pedagogy, as well as caring counselors, teachers, professors, and peers. These tried and true strategies are important for stakeholders to keep in mind as they consider ways in which the community college pathways for Latinx students can be strengthened.

Research on Latinxs in community college has suggested that stakeholders ought to invest in qualitative research to better understand how well the institution is serving them (Harper & Museus, 2007). Others have stressed the importance of increasing resources to stimulate interest in STEM, as well as to facilitate transfer to research institutions, as many Latinx students elect to attend less prestigious universities that do not focus on research (Malcolm, 2011). Institutional partnerships between community colleges and 4-year universities, as Excelencia in Education (2015) has suggested, may be an important starting point in order to move the needle on increasing transfer rates for Latinxs at this critical pathway. Articulation agreements, in which the 4-year institution accepts transfer students who have met certain requirements, is one strategy to strengthen the pathway. Another successful strategy, is to implement mentorship programs, in which the 4-year STEM students receive a stipend in order to mentor community college students and assist them with the transfer process. Considering the financial strain that many Latinx community college students face, offering fee waivers to apply to the 4-year institution could relieve a considerable amount of economic burden on students and increase transfer rates tremendously (Wood, 2014).

4. UNDERGRADUATE

According to Santiago, Soliz & Excelencia in Education (2012), only 8% of the baccalaureate degrees earned by Latinxs are in STEM. While some research has suggested that Latinx students that earn high marks in Physics and Calculus in high school have the highest likelihood of persisting in STEM majors in college, others warn against counting out students that did not fare as well in high school classes (Astin,1993; Gandara, 2001). HSI's that invest in their student's well-being with mentoring, a campus climate that is welcoming to Latinx students and their families, culturally relevant STEM courses, diverse faculty, cultural centers/programming, and programs that support academics, peer-group activities, and prepare Latinx students for graduate programs improve student's achievement and self-efficacy (Hurtado & Carter, 1996; Gandara, 2006; Oseguera & Rhee, 2009; Lord & Camacho, 2011; Pascarella & Terenzini, 2005). Therefore, the support that is given to Latinx students in college, may have more of an impact on Latinx persistence in STEM

than high school achievement. The importance of investing in a campus climate that is welcoming and invested in nurturing the inclusion of URM's cannot be overstated, as Hurtado, Carter and Spuler (1996) have asserted that even the most talented Latinx students have trouble adjusting when they face racism that makes them feel like they do not belong at the 4-year university.

While it is apparent that Latinxs are underrepresented throughout the many points of the STEM pathway, (Solorzano, Villalpando & Oseguera, 2005; Martinez, Cortez & Saenz, 2013) Santiago, Soliz, and Excelencia in Education (2012, 2015) have demonstrated that most degrees earned by Latinxs are concentrated at the associates or baccalaureate levels and that a majority of these degrees are conferred by a small percentage of institutions (particularly in California, Texas, Florida and Puerto Rico).

Programs such as the Ronald E. McNair (McNair) Scholars program have been effective in retaining and supporting undergraduate students in STEM because they offer undergraduate research opportunities and Ph.D. preparation for low-income, first generation college students (Seburn, Chan & Kirshstein, 2005). Since McNair is not a race-based initiative, it serves mostly white students. However, by creating a program that specifically requires equal representation of all students on campus, or making program recruitment more expressly targeted at Latinx students (Bensimon & Dowd, 2012), Latinxs have a better chance of not only persisting to baccalaureate, but the Ph.D. as well. Stakeholders interested in diversifying the STEM workforce should pay close attention to McNair pathways as well as community college, as these two entry points to STEM careers are where most Latinxs in STEM can be found.

5. GRADUATE SCHOOL

The Ph.D completion project revealed fewer than 60% of all students entering graduate school in the sciences will complete their doctoral degree within a 10-year time frame (Sowell et al., 2015). Sowell has further disaggregated these data and asserted that the completion rate is 54% for Latinos in the same time frame (Sowell et al., 2015). These statistics highlight the importance of supporting the few Latinx students at this critical pathway to professional careers in STEM.

Much of the literature on the Latinx graduate experience describes both the isolation and invisibility, and the determination felt by Latinxs graduate students (Rivas, 2012; Ruiz, 2013; Castellanos, Gloria & Yamimura, 2006). Ruiz has posited that, just as it is important for the K-12, community college, and undergraduate years, it is also critical for Latinx graduate students to be paired with peer mentors, learning communities, caring advisors that connect them to opportunities, and programming that offers financial support to attend conferences, conduct research, and finish in a timely manner (Ruiz, 2013). Ruiz also asserted that critical race pedagogy ought to be employed in graduate school for Latinx STEM students in order to create a welcoming climate that recognizes and challenges racism in order to make all students feel like they belong (2013). More research in order to better understand how this theory can be applied.

More research needs to be done on Latinxs in STEM at the graduate level, but researchers like Rivas (2012), who study Latinx transfer students who went on to Ph.D. programs have written about the communities that Latinx graduate students have to create on their own when the institution does not recognize their unique backgrounds and challenges. The Latinxs in Rivas's study shared experiences of feeling silenced in the classroom and the anger that resulted from constant racial micro-aggressions disparaging their communities. These narratives suggest a deeper issue in higher education as well as other institutions in the U.S. Racism and White supremacy too often go unchecked by administrators, and a multitude of researchers have continued to call for concerted efforts to diversify faculty, require critical race education workshops for faculty and administrators, and invest in a push toward equity (Bensimon, Dowd & Chase, 2012; Bensimon & Dowd, 2012; Gandara, 1995; Hurtado, 1996; Valenzuela, 1999; Rendon, 2003; Vasquez, 2005; Nunez, 2011; Sleeter, 2011). Placing value on Latinx cultural heritage is of the utmost importance as efforts move forward.

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NOTES

COLLECTIVE IMPACT: LESSONS LEARNED

Moderator: Sarita Brown, *Exelencia* in Education
Panelists: Tanis Crosby, YWCA Silicon Valley
Efrain Gutierrez, FSG/Cleveland Project
Susan Johnson, Lumina Foundation

Collective Impact (CI) models are emerging as a strategy to move the needle on educational disparities that remain relatively unchanged over time. Researchers on CI projects have highlighted the importance of agreement on a common agenda, shared measures, mutually reinforcing activities, continuous communication, and a strong backbone organization.

Stakeholders in these collaborations (including K-12 partners, university administrators, business and community leaders, philanthropic organizations, and government agencies) are encouraged to use their political capital as leverage for making long-lasting, systemic change. Although these collaborations have resulted in successful short-term changes, only a few have sustained long-lasting impacts after the initial funding has dried up.

This panel will focus on the factors that were implemented by contributors to successful CI projects and the suggestions they have for new collective impact efforts.

Principles For Effective Place-Based, Collaborative Work in Support of Latino Student Success

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1. INTRODUCTION

For the last four years, the thirteen sites participating in the Lumina Latino Student Success (LSS) effort have engaged in place-based collaborative work in support of Latino student success in higher education. The sites came together with the goal of increasing Latino student success in their region, but each site designed an initiative tailored to their specific context. As part of the summative evaluation for the Lumina LSS effort, FSG engaged Site Directors and the thirteen sites in the development of a set of principles for effective practice. The principles define the essential ingredients for success in place-based, collaborative work in support of Latino student success in post-secondary education.

These principles provide an opportunity for the sites to reflect on their experience and share what they have learned with Lumina Foundation and other practitioners in the field. We expect that these principles can be used by practitioners working to increase post-secondary attainment for Latino communities or other communities of color. The principles will be particularly relevant for collaborative, place-based work that requires adaptation to changes in social, political, economic, and cultural patterns.

2. ORIENTATION TOWARD LATINO STUDENT SUCCESS

2.1 Approach Latino student success with a positive, asset-based lens

Partners should build on the assets, strengths, and resources that reside within the Latino community as they approach their collaborative work. By celebrating and highlighting the positive elements of the Latino community, partners can contribute to a positive change in narrative and increased opportunities for Latino students.

Example: Many sites applied an asset-based lens in how they talked about their work. For example, they reframed the "achievement gap" as an "opportunity gap." Sites also described their part-time Latino students as "post-traditional" or "XXI Century" students instead of "non-traditional." Southern sites also applied an asset-based lens when trying to create a sense of urgency for Latino student success. They talked about how Latino students represent an opportunity and a source of untapped potential to improve the overall economic conditions of their communities.

2.2 Treat students' education as a family affair

Going to college is a family decision for many Latino students, and collaboratives should include strategies for authentic engagement with families. These strategies should inform and engage parents and other family members throughout the higher education process, including college preparation, enrollment, and attainment. Informed and engaged families will provide a supportive environment that will help students stay on track and graduate from college.

Example: **Padres Promotores de la Education** or "Parent Promoters for Education" is a successful family engagement program supported by the Santa Ana Partnership. Every year, a group of around forty parents are recruited to serve as promoters and link families to school services. Promoters deliver higher education information to families in both Spanish and English using home visits, informal dialogues, and community meetings (e.g., neighborhood association meetings). This program has been an effective vehicle for the Santa Ana Partnership for authentic, peer engagement with the families of Latino students in their community.

2.3 Ensure that Latino students are involved in the decision-making process

One powerful way to be responsive to Latino students is to invite them to participate and ensure they have a voice in conversations and decision making processes as participants within the collaborative or as experts to share their experiences and needs. The direct participation of Latino student voices in setting strategies and tackling challenges ensures that the efforts of partners are focused in areas that will make a difference to Latino students. The inclusion of Latino students is also an opportunity to build their capacity as leaders and advocates for their needs and the needs of their community.

Example: K'LEA, the Lumina LSS effort in Kentucky, has been very intentional about including the voices of Latino students in its decision-making process. Starting in the planning period, the Site Director invited a student representative to sit on the leadership team. The student representative participated in the regular meetings and helped keep the assets and needs of Latino students always present. K'LEA utilized this opportunity to build students' leadership capacity. As a result, one of the students participating in the leadership team is now a key leader of K'LEA and will help shape the next chapter of the effort.

3. PARTERNSHIP WITH THE LATINO COMMUNITY

3.1 Support deep engagement of local Latino leaders

Collaboratives should honor and recognize the work of those who have been working in support of the Latino community by bringing them to the table as effective allies and leaders. Engaging with Latino leaders as visible and strong partners will provide insights into the community, create buy-in, and legitimize the work of the collaborative in the community.

Example: When the **Tennessee Higher Education Commission (THEC)** decided to apply to the Lumina LSS effort, it recognized the importance of engaging Latino leadership. During the application process, THEC reached out to **Latino Memphis**, a local nonprofit focused on the Latino community, to co-write the proposal and co-lead the effort. Both parties benefited from the partnership: THEC provided relationships at the state level and experience in the education field, while Latino Memphis brought credibility and engagement with the Latino community in Memphis. Their partnership helped build Latino Memphis' capacity and prepare it to manage *Abriendo Puertas*, the local Lumina LSS effort, on its own.

3.2 Understand the Latino community you serve, and the broader political, economic, and cultural context

Collaboratives should take the time to learn deeply about the landscape of the Latino community in their area—its origins, norms, assets, and challenges. Partners should take the time to understand and acknowledge the diversity within the Latino population and the varying needs that different sub-groups may have. Having a clear understanding of the community helps develop effective strategies to help Latino students overcome the particular challenges they face. Collaboratives should also look into the broader political, economic, and cultural context and how these characteristics can positively or negatively affect outcomes for Latinos students.

4. STRATEGY FOR THE COLLABORATIVE EFFORT

4.1 Develop and share a common vision and plan for action while remaining adaptive and flexible

Partners in the collaborative should develop a clear agreement on the vision, goals, priorities, roles, and expected outcomes with mechanisms for follow up. Partners need to have an understanding of where the effort is going, how it will get there, how it will build off of previous efforts, and what role they play, while also remaining adaptive in light of complex and sometimes unexpected circumstances. To maintain engagement, partners need both a shared goal that is bigger than their own organizations, but also a clear benefit from their participation.

Example: Degree Phoenix, the Lumina LSS effort in Phoenix, AZ, developed a broad plan of action across the full education pipeline, from college readiness to attainment. The plan included the goals and priorities of the partners participating in the effort, but it proved to be too broad and ambitious. As the partners began implementation, they realized it was hard to get traction because they were working on too many fronts at the same time. When they saw partners frustrated for the lack of traction, the site remained flexible and created a more targeted focus on the areas of the pipeline where they had existing momentum. This change allowed the site to keep partners engaged and aligned around shared goals.

5. FOCUS ON CHANGING STRUCTURES, POLICIES, AND SYSTEMS

To make a difference for Latino students, the collaborative should think of itself as a long-term effort to change systems in support of Latino students' access to and graduation from college. It is hard to achieve significant, broad improvements at the community level without making changes to the policies and structures that prevent Latino students from graduating. Policy change at the institutional, local, and state levels is an important tool for sustaining long-lasting change. For some emerging Latino populations, advocacy training and leadership development may be the first step toward eventually changing structures, policies, and systems.

6. COLLECT MEANINGFUL, CREDIBLE, AND USEFUL DATA TO LEARN AND TRACK PROGRESS AND IMPACT

It is important for collaboratives to collect credible data that will help assess progress and facilitate continuous learning among partners. Partners should have a mechanism to hold each other accountable and determine areas of progress and challenge in a transparent manner. Robust and meaningful data can help collaboratives adapt their strategies to the changing environment to increase the impact on Latino student success.

Example: Promise Pathways, the Lumina LSS effort in Long Beach, CA, believes that having a common vision and working together on a shared purpose is not enough if you do not have data to track progress and help partners learn in real time. They prioritized data collection for learning and tracking progress. Every year, the effort develops a robust annual report with clearly defined metrics that help the different partners understand their own progress and the overall achievements of the collective effort. The site focused on disaggregating data by race/ethnicity and using these data to observe the areas where Latino students are making progress, as well as to make changes to their strategy in areas where Latino students required additional support.

7. COLLABORATION AMONG PARTNERS

7.1 Bring the right "*colegas*" to the table at the right time

Representatives from the organizations involved in the collaborative, as *colegas* or colleagues, should commit time to the partnership and make decisions within their institutions as relevant to the collaborative's work.

Also, not everyone has to be at the table from the very beginning of the effort. Think about engaging some of the most critical partners first, those who are willing to collaborate and come together. Then, develop a plan to recruit and meaningfully engage any critical partners that haven't yet been engaged.

Example: Diplomás, the Lumina LSS effort in San Antonio, TX, was very strategic in terms of who to engage during the planning process. They decided to work with two post-secondary institutions with the most Latino students – Alamo College and University of Texas San Antonio – and with the four school districts with the highest concentration of Latino students. They could have invited private universities or more school districts, but they determined that it was important to start with a targeted group of partners. Working with a smaller group allowed them to make progress with those who were ready to collaborate, creating the necessary structures and processes before inviting others to the table.

7.2 Treat your partners as *"familia"*

Similar to a family, all members of the collaborative should act like they are part of the same team. This includes ongoing, open, transparent, and inclusive communication with one another. Each partner should have a sense of investment; so that challenges are shared and solved collectively while small wins and major successes are also collectively celebrated, giving credit to all the organizations involved.

Example: The UNIDOS project, the Lumina LSS effort in Albuquerque, NM, emphasized the need to ensure that members of the collaborative felt like *familia* and had ownership on their collaborative effort. During the planning process, the effort engaged with a set of cross-sector partners to create a plan that was responsive to local culture and reflected the areas of focus prioritized by the participating institutions. Creating a sense of shared ownership was critical for the success of the effort. Partners continued coming to the meetings and engaging in the work because they have seen the benefits. A critical tool to keep partners engaged was publicly sharing credit for and celebrating early wins among partners.

7.3 Cultivate "*confianza*"

The concept of "*confianza*" translates as "trust," but encompasses ideas of confidence and familiarity.

Confianza requires the ability of partners to trust each other not only professionally, but personally as well. It is important for collaboratives to create spaces where partners can meet with one another and connect on a personal level (e.g., provide food or drinks before or after a meeting, organize regular networking event for partners). With a deep level of trust and confianza among partners, strong collaboration becomes possible.

Example: CREAR Futuros, the Lumina LSS partnership in New York City, NY, has been successful in the educational policy arena thanks to the development of "*confianza*" among partners. The effort took steps to create a comfortable environment for partners in their educational policy group by gathering informally to engage in dialogue and getting to know one another. Informal meetings helped partners feel comfortable at the table knowing that they were among trusted friends. Thanks to the development of *confianza*, this group developed an educational policy blueprint, much of which was adopted by the New York City Mayor's administration this year.

7.4 Provide ongoing support for effective leadership

Investing in the collaborative's leadership is key for effective engagement with partners and external stakeholders. Given the critical nature of leadership, collaboratives should seek ways to provide regular and continuous support to their leader(s) to ensure that they have strong facilitation, management, and convening skills.

Example: The Triangle for Latino Student Success, the Lumina LSS effort in Durham, NC, benefited from the leadership of a Site Director that fostered collaboration and had excellent facilitation skills. The site worked to align different coaching programs at three independent CBOs. Thanks to the Site Director's ability to facilitate the dialogue, the team stayed on track and moved forward with the alignment of the three coaching programs.

8. ACKNOWLEDGEMENTS

The reflections in this paper were generated as part of the summative evaluation of the Lumina Latino Student Success effort. The final report was delivered to Lumina Foundation in December 2015. As part of the evaluation the FSG team conducted the following evaluation activities:

- Analysis of sites' 2014 annual grant reports
- Review of community-level academic indicators and evaluation reports provided by sites and site evaluation reports from previous years
- Interviews with eight Lumina Foundation and *Excelencia in Education* staff
- Online survey with 60 key site-level participants
- In-depth online survey with 13 Site Directors
- Phone interviews with 13 Site Directors and local evaluators, and 13 interviews with site partners
- Reflection session during the 2015 Lumina LSS Annual Convening with leaders from the thirteen sites, Lumina Foundation, and *Excelencia in Education*
- Site visits to Memphis and Albuquerque to conduct interviews and focus groups with site partners, Latino students, and parents

NOTES

DISCUSSION:

COLLECTIVE IMPACT

K-12 PIPELINE: FROM COMMUNITY TO CAMPUS

Moderator: Mary Fernández, MentorNet, a division of Great Minds in STEM

Panelists: Njema Frazier, Algebra by 7th Grade
Andrés Henríquez, New York Hall of Science
Saundra Johnson Austin, Charis Consulting Group LLC

Research on Latinas/os in K-12 has revealed that students who are exposed to science and math in elementary school classes and extra-curricular programs, and who are encouraged to pursue STEM by culturally sensitive mentors, are more likely than their peers to matriculate into high-level math and science courses in high school such as calculus and physics. And, students who persist in these courses in high school, receive institutional support, and achieve high GPA's are likely to have a positive academic self-concept and enter STEM fields in college. Yet there is insufficient research on how to make STEM more culturally relevant to K-12 students and how to provide a welcoming environment for girls, and especially girls from underrepresented minorities.

This panel will focus on ways in which K-12 institutions and community partners can better support students by providing them with positive experiences in math and science courses, as well as how collaborations with community colleges, community based organizations, and 4-year universities can create a wider set of pathways from K-12 into college and, ultimately, STEM industry.

Ab7G: An Early Intervention Model to Increase the Pool of Minority Students Prepared to Pursue STEM

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ABSTRACT

According to the National Assessment of Education Progress (NAEP), only 7 percent of Black 12th grade students scored at or above Proficient in mathematics based on the subject-matter knowledge and analytical skills deemed appropriate for that grade level (fig. 1). For 4th and 8th graders the number scoring at or above Proficient was 19 and 13 percent, respectively (fig. 2). Those proficiency numbers translate directly into the number of underrepresented K-12 students eligible to pursue Science, Technology, Engineering, and Mathematics (STEM) degrees in higher education.

To address this performance gap in mathematics, and embark on a path of growing the pool of minority student eligible for STEM majors, a team of leaders from different minority technical organizations conceived of – and launched – the Algebra by 7th Grade (Ab7G) Initiative.

The purpose of Ab7G is to increase the number of underrepresented 7th grade students in the US that are academically prepared to take algebra. The program provides advanced math preparation to 3rd – 7th grade students through a combination of on-line and in-person instruction.

This paper focuses on program analysis, not student analysis, and discusses the implementation, analysis, and recommendations for scaling Ab7G beyond the 5-year pilot (Fall 2014 – Spring 2019).

Keywords

Science, Technology, Engineering, Mathematics, STEM, STEM education, diversity, Common Core State Standards, pilot, K-12.

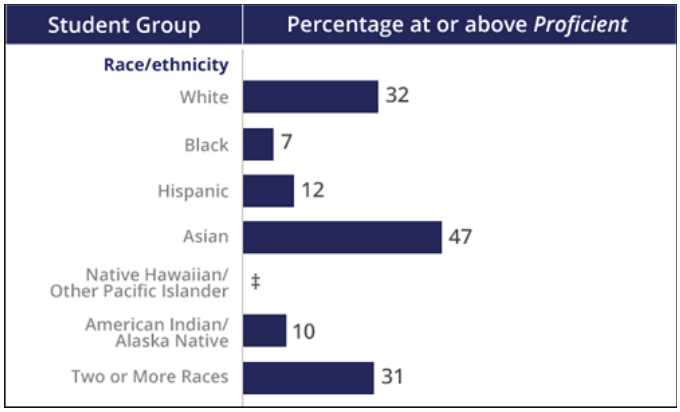


Figure 1: Percentage at or above Proficient in NAEP mathematics at grade 12, by select student groups: 2015

1. INTRODUCTION

The Algebra by 7th Grade Initiative is an umbrella program led by a multi-organizational steering committee. It is designed to be a substantive, high-impact initiative that is highly-scalable, replicable, and versatile for myriad organizations and organizational programming models. Organizations that implement Ab7G seek to reduce the gap in student performance for Black and Hispanic students as compared to their White and Asian peers.

Desired student outcomes include (1) accelerated mastery of math concepts (at a rate which will result in a 5-year advancement in 4 years), (2) improved performance on standardized tests, (3) improved academic performance, (4) improved attitudes towards mathematics, and (5) achievement of a performance level that meets, or exceeds, proficiency for Common Core State Standards (CCSS).

Ab7G centers around a few core elements and methodologies, beyond which it allows for sufficient variability to conform to the programs, schedules, structures, and constituencies of each individual host organization.

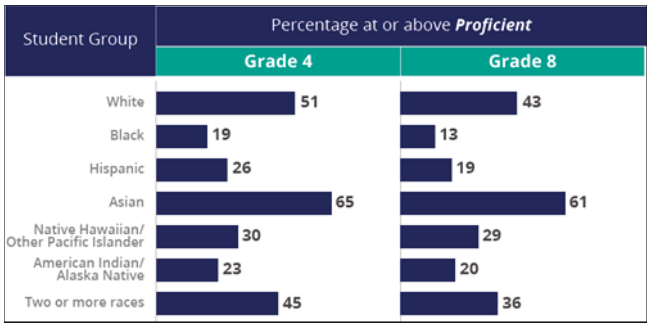


Figure 2: Percentage at or above Proficient in NAEP for selected student groups in 2015, grades 4 and 8

There are four core tenets of the Algebra by 7th Grade Initiative:

1. Integration: Incorporation of enhanced math rigor into the base programming of the host organization;

2. Acceleration: Implementation of an ancillary, year-round math program that uses blended learning to augment the standard academic curriculum and enable mastery of foundational math concepts;

3. Engagement: Commitment to a 5-year program beginning in 3rd grade and running through 7th grade; and

4. Research: The tracking, monitoring, and assessment of student performance and attitudes towards math.

These tenets provide a robust framework and methodology for Ab7G, while still affording organizations the flexibility to align the program to their operational, programmatic, and scheduling constructs.

2. DESIGN AND METHODOLOGY

The Ab7G objectives are to improve student mastery of math concepts by 1.25 years each academic year [to result in a cumulative advancement of 5 grade levels in 4 years], student performance on standardized tests, student academic performance in mathematics, student attitudes towards mathematics, and achievement of a performance level that meets, or exceeds, proficiency for Common Core State Standards (CCSS).

The two implementation strategies are summarized below

Model A: In-Situ Classroom Implementation

Identify a single 3rd grade classroom within a school that can adjust to offer gifted and talented track programming from grades 3 through 7; track the class to an accelerated on-line curriculum (such as IXL or ALEKS); offer tutoring via established program channels; provide STEM programming over the summer.

Model B: Ancillary Implementation

Identify a specific cohort of 3rd graders from local areas schools whose parents will commit to 5 years of Ab7G; test 3rd grade cohort to determine their initial level of proficiency; provide a packaged math tool (i.e. ALEKS) to accelerate learning; offer face-to-face sessions after school or on weekends; provide "anchor" STEM programming during summer months.

2.1 On-line Instruction

Three of the four cohorts in Ab7G adopted a web-based, assessment and learning system known as ALEKS–Assessment and LEarning in Knowledge Spaces. ALEKS uses adaptive questioning to quickly and accurately determine which concepts a student has and has not mastered. This adaptive questioning also allows ALEKS to deliver targeted instruction on the topics the student is most ready to learn. As a student works through a course, ALEKS periodically reassesses the student to ensure that topics learned are also retained.

The fourth Ab7G Cohort used the IXL on-line math tool, an immersive K-12 learning environment that provides comprehensive, standards-aligned content for math (as well as language arts, science, and social studies). Both ALEKS and IXL are aligned to the Common Core State Standards.

2.2 In-person Instruction

The responsive in-person curriculum employed by Ab7G is based on real-time student progress in ALEKS. These sessions include lessons to address knowledge gaps and academic concepts that the students are "ready to learn" – as prescribed by ALEKS. Additionally, instructor observation and guidance to ensure effective utility of ALEKS to maximize learning, group exercises and community building, self-efficacy, exposure to role models, hands-on activities.

Ab7G sites employ a Lead Instructor and two Associate Instructors who work with the student cohorts. The instructors drive in-person student learning within the Ab7G model and develop an overarching atmosphere in which students can maximize their learning potential.

The Lead Instructor is responsible for direct instructional preparation as well as the development of learning objectives for each session, tracking the progression of the student population as whole within the ALEKS program, monitoring the impact of the ALEKS program on students' academic records and

standardized tests, administering progressive testing to students to track their progress within ALEKS, and strengthening the math comprehension of all students within Ab7G.

The Associate Instructors monitor and assist in the instruction of the student cohorts throughout the academic school year. The instructors work with the students as they strive to improve not only their math skills, but their comprehension of prerequisite concepts for algebra. Associate instructors also build the community of students, and promote enthusiasm and positive attitudes towards math.

2.3 Learning Standards

The on-line and in-person instruction elements work coherently to drive towards the accelerated knowledge and mastery of math concepts, increasing the percent of Ab7G students attaining the levels of basic, proficient, and advanced.

Per the definitions in CCSS, Proficient, the central level of achievement, represents solid academic performance for each grade assessed. Students reaching this level have demonstrated competency over challenging subject matter, including subject-matter knowledge, application of such knowledge to real-world situations, and analytical skills appropriate to the subject matter. Below Proficient lies Basic, the achievement level denoting partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at each grade assessed; and above Proficient lies Advanced, the level denoting superior performance.

3. IMPLEMENTATION

The first step in implementing the pilot was to assess the feasibility of the individual organizations – in this case the National Society of Black Engineers (NSBE) and College Tribe – to host an Ab7G program. This required participation in an Ab7G interest meeting so that organizations could be briefed on the core elements that make host program part of the Ab7G Initiative. The next step was to measure the organization's capacity against the requirements and make a go, no-go decision.

An abbreviated list of requirements is included in Table 1. and include staffing the program, selecting students, and ensuring that the on-line math tool is available.

☐	Facility space – Students	☐	Site Manager
☐	Facility space – Parents	☐	Instructors
☐	Student Cohort	☐	On-line Software Licenses
☐	Supplies/ Materials	☐	Student Registration Tool
☐	Selection Committee	☐	Registration Fee
☐	Annual Calendar	☐	Curriculum Manager
☐	Laptops	☐	Quarterly On-line assessments
☐	In-Class Exercises/ Activities	☐	Student Waivers/ Disclosure Forms
☐	Standardized Test Evaluation	☐	Affiliated Summer STEM Program

Table 1: Exerpt from Ab7G Requirements Checklist

4. PROGRAM ANALYSIS

4.1 Student Progress

The quantitative and qualitative results for the program have been positive. Qualitatively, students have shown a marked improvement in their attitudes toward math, as well as other academic classes. They have formed positive relationships with students within their cohort that motivate them to continue to actively engage during the in-person sessions. Quantitatively, more than 85% of the students that have been in Ab7G more than 1 year are performing at or above the average proficiency level for minority students in the corresponding grade level.

Students have begun working more independently now that they are familiar with ALEKS and the tools functionality in directing them to the next learning activity.

Parents reported that the students are motivated by the awards received for completing activities, as well as the medallions given out in the onsite sessions. They've been able to use this motivation to encourage their child to log into ALEKS on a regular basis.

Most parents reported that their children continued to enjoy math, and remained engaged and doing well in the subject. Parents also reported their children being ahead of their peers in math as a result of participating in the program. Teachers have noted that the student is already familiar with the material when it is presented.

4.2 Evaluation Methods

On-line evaluation of skills is determined by ALEKS, which uses evaluations to determine aptitude and measure progress.

Pre- and post-tests are administered as part of the in-person sessions. Ab7G uses the Partnership for Assessment of Readiness for College and Careers (PARCC) mathematics practice test as a pre-test before the fall semester begins and at the end of the year. PARCC tests represent a consortium of 11 states and the District of Columbia.

4.3 Program Improvements

While the students are clearly benefitting from the initiative and the NSBE pilot is on track to complete its 5-year duration, key areas of improvement have been revealed through the execution of the programs hosted by NSBE and College Tribe. These areas include site selection, site preparation, socialization, host agreements, and understanding of roles and responsibilities. To successfully re-launch the initiative following the pilot, it will be imperative that all parties are aware of, and able to support, the initiative at the needed level for the entirety of the commitment expected of the host.

Unfortunately, staffing and budget issues at College Tribe made it unfeasible for them to continue their program in Year 2.

Improvements also need to be made to the on-boarding process and briefing of Ab7G staff and volunteers on the details, requirements, and expectations. The pilot demonstrated that the integrity of the program hinges on the uniform understanding of the importance of the four tenets: Integration, Acceleration, Engagement, and Research. These tenets work as an ensemble, and neglect in any one area can compromise results; whether it be student performance, continuity, retention, or data collection.

5. RECOMMENDATIONS

The four key recommendations for Ab7G are listed below:

Recommendation 1: Build a detailed briefing program for prospective host organizations. The briefings should cover the scope, needs, requirements, and commitment involved in embarking upon an Ab7G program. Clarity surrounding these components is essential for the prospective program director and host organization. Before any steps are taken to launch an on-site program these factors – scope, needs, requirements, and commitment – must be uniformly understood and agreed upon.

Recommendation 2: Build a toolkit for host organizations seeking to launch and execute an Ab7G program. There are hundreds of details – activities, events, processes, contacts, documents, and timelines – that need to be reviewed and acted upon from before the launch to after the last 7th grader takes algebra.

Recommendation 3: Create a detailed year-1 timeline of parent, student, staff, host, and Ab7G actions from the day a new program is approved.

Recommendation 4: Collect the student data and use that data to refine the program of record and set learning standards and expected learning outcomes based on participation.

6. ACKNOWLEDGMENTS

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Darryl A. Dickerson, Ph.D., Associate Director Minority Engineering Programs, Purdue University

Shatwariya Findley, Technology Consultant

Joe Haralson, Ph.D., Professor of mathematics and Education Consultant

Beachrhell Jacques, Lead Instructor, Ab7G

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Peter Clare, fmr. Executive Director of College Tribe

Tom Price, fmr. Ab7G Site Liaison, National Society of Black Engineers (NSBE)

Matthew Clark, frm. Ab7G Site Manager, Program coordinator for National Society of Black Engineers (NSBE)

James Stephens, fmr. Associate Instructor, Ab7G, Engineering student

Jasmine Gordon, fmr. Associate Instructor, Ab7G, Engineering student

Patrick Wilborn, fmr. Lead Instructor, Ab7G, College Tribe

And finally, this would not be possible without the two host organizations that agreed to launch the Ab7G pilot: the National Society of Black Engineers and College Tribe.

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QUEENS 20/20: Creating Authentic Opportunities for Immigrant Parents in a STEM Ecosystem

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ABSTRACT

At a time when scientific and technological competence is vital to the nation's future, the underachievement of U.S. students in science in part reflects the uneven quality of science education. In New York City, for example, 62% of eighth grade students scored *below basic*, 24% performed at the Basic level, and only 13% scored at the Proficient level on the Science portion of the National Assessment of Educational Progress Trial for Urban District Science Assessment, often referred to as our Nation's Report Card, (National Center for Education Statistics, 2011). It has long been recognized that the level of pre-K-12 Science, Technology, Engineering, and Mathematics (STEM) education in the U.S. – particularly in poorer communities – is inadequate. For instance, a National Academy of Science report on minorities in STEM revealed that low-income families of color still do not have access to quality STEM education, which is linked to minorities' underrepresentation in STEM careers (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce (US), & Committee on Science, Engineering, and Public Policy, 2011). The lack of STEM preparation among younger children from these communities (due largely to shortages in school resources, teacher professional development, and family involvement) undermines success in secondary school, college, and careers. STEM competencies (critical thinking, reasoning and argumentation, meta-cognition) have been shown to be vital for success in the 21st century workplace (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce (US), & Committee on Science, Engineering, and Public Policy, 2011); so remedying this situation is of great national importance.

Shifting demographics and an increased national focus on STEM for workforce development demands that we broaden community and family participation to foster STEM interest and knowledge in students. In the fall of 2016 the New York Hall of Science (NYSCI) launched *Queens 20/20* – An Ecosystem for STEM Learning, which is creating a model for broad and deep networks of STEM-rich learning opportunities in high-need immigrant communities. Queens, New York is often referred to as the crossroads of the world with a population of 2.3 million people, nearly half of whom are immigrants. Through strategic partnerships with community organizations, local elected officials, schools, and education leaders, *Queens 20/20* offers a multifaceted program of work that engages students, teachers, families, and community members in creative STEM learning.

Keywords

Immigrants, Latinx, STEM, STEM Ecosystems, Parent Engagement

1. INTRODUCTION

As part of *Queens 20/20* NYSCI launched a *Parent University*. The goal of *Parent University* is to help parents increase their awareness of STEM career opportunities for their children and to offer tools and resources to help their children achieve academic and career success. *Parent University* builds on six years of grassroots community outreach that has built a network of 17 local schools and a tight partnership with the leadership of District 24 – the local church, Our Lady of Sorrows and local non-profit organizations. NYSCI is utilizing a two-generation approach, where both children and parents are engaged in STEM learning. Our long-term goal is to convene organizations and sectors that do not typically work together to share knowledge, best practices, lessons learned, and outcome measures to determine effective and

innovative models in the service of successful STEM careers for first generation children and their families.

Parent University works uses a variety of strategies to engage parents. The program:

Provides parents with tools and resources (to help them understand and navigate the school system in New York, throughout the continuum of their child's education (Pre-K to College);

Increase awareness and access to essential STEM academic coursework and real pathways to STEM-related careers;

Emphasizes a two-generation approach— for children AND families—to provide STEM programs that privilege creativity, hands-on exploration;

Offers activities across multiple settings with parents, parent associations, Community School District 24, and other community members to foster student success and learning as a shared responsibility; and

Gives local immigrant parents and families a voice and a platform to ensure their concerns, challenges, and stories are recognized throughout the district, city, and nation.

2. RESEARCH QUESTIONS

Given these goals the following research questions or goals of the inquiry were posed to parents:

- How do parents perceive their children vis-à-vis STEM?
- What are children's access to STEM-rich opportunities in school? Out of school?
- What are the ways in which parents navigate the transitions from one school to another (i.e., elementary to middle and middle to high school)?
- How are other parent groups engaging parents in their child's STEM education?

Two of the main objectives of NYSCI's *STEM Ecosystem* are to promote parent and family engagement and to deepen relationships with community stakeholders**.** Parental support in taking children to informal learning institutions (libraries, museums) and STEM relevant afterschool programs has been shown to have a positive effect on children's participation in math and science activities in general (Simpkins, Davis-Kean, & Eccles, 2005). Studies have also shown that parents who convey the importance of STEM subjects motivate their children to take more science and math courses (Harackiewicz, Rozek, Hulleman, & Hyde, 2012; Rozek, Hyde, Svoboda, Hulleman, & Harackiewicz, 2015). Furthermore, there is support from the research that family engagement for young people of all ages yields positive results: children stay in school longer, perform better in school, and they generally have better school experiences. This is consistent across grade levels in formal and informal school contexts (Henderson & Mapp, 2002; Jeynes, 2005; Lopez & Caspe, 2014). Parent engagement in STEM, particularly for those with underserved young children, has a powerful effect on children's learning. When given more direction, parents from diverse backgrounds can become more engaged with their children—and when parents are more engaged, children tend to do better in STEM (Van Voorhis, Maier, Epstein, & Lloyd, 2013; NSTA, 2009).

Research suggests that immigrant parents face challenges in facilitating their children's STEM learning. Parents with children who are English language learners have double the amount of work; having to learn both English and the language of science and mathematics (Short and Fitzsimmons, 2007). Even though parents see themselves as important to inspiring their children's interest in STEM learning, almost a third do not feel comfortable in their own STEM knowledge to adequately support academic and career next steps for their children (Jackson & King, 2016).

For years, parent engagement has focused on parents advocating for their children in school. Parents who are newcomers to this country may receive support, but it is often focused on immigrant rights and advocacy. Improving child outcomes depends on supporting families in gaining access to guidance and support on a range of issues. In *Children of Immigration,* Suarez-Orazcos (2001) identified a split between aspirations and actual choices that grows over time as children encounter obstacles. NYSCI's work is intended to address this split in such a way that aspiration and choice are effectively coupled and parents and their children have the knowledge and opportunities required to embrace career and academic next steps in STEM fields.

3. AUTHENTIC UNDERGRADUATE RESEARCH EXPERIENCES

3.1 Focus Groups

Queens 20/20 held two focus groups with 20 parents at NYSCI (to parents in each group). The overall goal of the focus groups was to learn parents' perspectives of their children's career aspirations vis-a-vis their future role in the STEM workforce. Parents were recruited from local schools. Each focus group lasted 45 minutes and was conducted in both Spanish and

English. The interviewer asked a range of questions focused on participation in STEM and STEM careers.

3.2 Interviews

In addition, NYSCI staff spoke to a number of stakeholders involved in family and community engagement: the district superintendent, assistant superintendent, and a number of math and science teachers. A community advisory board was established as part of the *Queens 20/20* initiative and monthly meetings were held to get advisory's input on the development of *Parent University*.

Queens 20/20 staff also met with NYSCI Neighbor school principals, the district's Director of Parent Coordinators, and New York City Department of Education's Family and Community Engagement staff to better understand and build on parent engagement efforts taking place in the school district.

3.3 Informal Landscape Analysis

Finally, we did an informal landscape analysis that reviewed existing local and national parent engagement resources and platforms. We used this analysis to get a better understanding of the some of local and national efforts in parent engagement and STEM. To conduct the analysis, we met with the main Queens library staff as well as with local Corona librarians to explore parent engagement strategies. We also had discussions with national providers, including Learning Leaders, Parent Institute for Quality Education members, and Home Instruction for Parents of Preschool Youngsters (HIPPY) personnel, and Be a Learning Hero staff.

4. FINDINGS

Our findings are based on themes drawn from multiple focus group conversations with community stakeholders, as well as through a landscape analysis of existing programs doing work with parents and children.

Among the resources explored in the landscape analysis was Be a Learning Hero's comprehensive national parent survey, "Parent 2016 Hearts and Minds of Parents in an Uncertain World," surveying 1,200 K-8 parents. When asked "what keeps parents up at night" about financing college and children's social emotional health and safety, a majority of Hispanic parents were most concerned about their "Ability to pay for/finance child's education" (70%), their "Child's emotional health and happiness" (67%) and their "Child's physical safety" (67%). When asked about what keeps parents up at night in referring to their academic progress, health and nutrition, and standardized testing, a majority of Hispanic parents were concerned about "Child's health and nutrition" (60%) followed by "Children gaining knowledge/skills needed for college" (58%) and their "Children being on track with academic expectations for his/her grade level" (56%) (Be a Learning Hero, 2016). We used this analysis to see how our local effort would compare to a national representative sample.

In focus groups, when we asked parents "What kind of place would you like NYSCI to be for your family?" Parents reported wanting:

- A clear starting point; they don't want to feel out of their depth;
- A place that is comfortable and accessible, and where they can learn and have fun with their children;
- To interact with people who speak their native language;
- A place where the *entire* family is welcome – multi-generation and multi-caretaker families are common in the community;
- To feel informed about the educational value of what their children are doing (e.g., connections to STEM subject matter, and to learning skills like problem-solving, teamwork and critical thinking); and
- To know how science is connected to their cultural traditions and practices.

It was clear from the focus groups that immigrant parents are disconnected from school. Additionally, the focus groups revealed that parents are too intimidated to ask questions about their children's future and trajectory. What's more, parents found it difficult to understand how to navigate a complex school system for their children, specifically when it comes to STEM education and STEM schools.

From NYSCI's findings across the focus groups, conversations with multiple stakeholders, and the landscape analysis, there is evidence that parents desire:

- STEM information that empowers them to be effective role models and help them make better decisions for their families (e.g., ESL class, health and nutrition; child development, environmental issues);

- To be in the driver's seat and learn how to support their child in STEM learning and academics in general;
- Accessible and easy to understand information about middle, high school, and college access;
- Aspirations for their children to be validated and specific steps to help their child realize his/her ambitions (proficiency or passing is not enough); and
- A safe, secure, and welcoming learning environment that won't compromise their family or child's privacy.

A direct outcome of the focus groups was to develop a framework for *Parent University* (see Figure 1.1) with the goal of developing culturally responsive programming for families, enabling them to navigate the complex school system and engage directly with the STEM learning process.

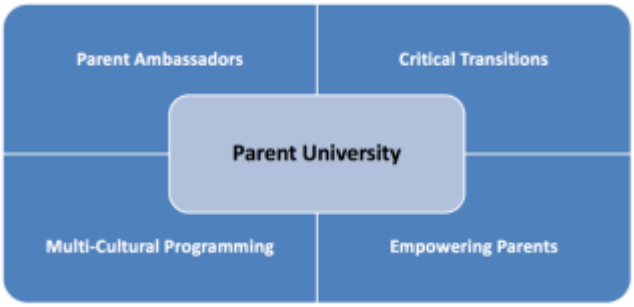


Figure 1.1 – The Parent University Model

The *Parent University* framework includes:

1. A Parent Ambassadors program where parents have the opportunity to learn about STEM concepts in a hands-on science center environment and grow as leaders and STEM advocates in their community.
2. Resources that will help them navigate critical school transitions and opportunities available in STEM-focused high schools, colleges, and careers in linguistically and culturally attuned settings.
3. Empower parents by offering courses and opportunities in collaboration with partners like the NYC Department of Education's Adult and Continuing Education and others to engage them as learners and increase their understanding of how science can help them make informed decisions for their families.
4. Development of multicultural programming so parents see NYSCI as a place for them, one that honors STEM in diverse cultural contexts.

One parent, Sylvia Sanchez[1], a Community Advisor, PTA president and a parent of two young children attending schools in District 24 expressed what many parents have conveyed to NYSCI. She wants her children to feel motivated by what's possible – becoming an astronaut or engineer – but she also wants those dreams to be *attainable*. As a parent she is absolutely committed to helping them achieve their goals and aspirations, but she wants to know how to best support her children with actionable steps.

5. IMPLICATIONS FOR BROADER IMPACTS

Parent University is a key programmatic component of NYSCI's *Queens 20/20*—a hyper-local initiative in a high need *and* highly aspirational community where first and second generation Americans are offered real pathways out of poverty through a pipeline of STEM programs and opportunities. Parents are essential to this work; they are an indispensable part of the success of their children. When families are involved, children are more engaged, learn more, and over the long term, are more likely to attend school and graduate (Harackiewicz, Rozek, Hulleman, & Hyde, 2012; Jackson & King, 2016). There several hundred communities like Corona—ports of entry for newcomers, cities and suburbs being settled by families from different countries escaping war and poverty and looking for a better life for their children. Parents in communities like Corona need support and resources like the *Parent University* to help them serve as the best possible advocates for their children, particularly when it comes to their academic and STEM career opportunities.

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[1] Sylvia Sanchez's name is an alias.

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A Solution to Broaden and Diversify the STEM Pipeline through Disruptive Innovation & Collective Impact

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ABSTRACT

The problem that this paper addresses is the lack of underrepresented minorities (URMs) graduating with Bachelor's degrees in science, technology, engineering, and mathematics (STEM) fields from 4-year colleges and universities in the United States. The National Science Foundation (2013) considers three racial/ethnic groups underrepresented in science and engineering – Blacks, Hispanics, and American Indians or Alaska Natives – because their representation in science and engineering is smaller than their representation in the United States. In some STEM fields, women are also underrepresented. "Adding more women and minorities to the STEM talent pool is crucial to America's future" (Carnevale, Smith, & Melton, 2011, p. 69). The evidence shows that China produces five engineers for every two engineering degrees granted by U.S. institutions (Anderson & Dongbin, 2006). This problem is important to address because more URMs and women are needed to enter the workforce if the United States is to remain globally competitive. This paper explores the factors that are contribute to the lack of URMs earning Bachelor's degrees in engineering: (1) a population of students who are underprepared; (2) low numbers of high schools adopting computer science courses as math or science credit; (3) low engineering degree completion rates for URMs, and (4) offers a novel, innovative solution to address the problem.

Keywords

Science, Technology, Engineering, and Mathematics (STEM) education, diversity, computer science

1. INTRODUCTION

Research shows the United States needs to improve science and mathematics education to remain globally competitive. "STEM has emerged as the educational priority of the 21st century" (Parry, 2015, para. 1), even though Ehlers (2005) states there is slippage of America's science and math education. The U.S. is ranked 27th in science and engineering Bachelor's degrees among 29 wealthy countries, and ranked 31st in math and 23rd in science high school achievement among developed countries (Zuckerman, 2016).

2. UNDERPREPARED STUDENTS

Regarding math proficiency, African Americans take high school calculus at a rate of 6.1 percent, Latinos at 8.6 percent, Whites at 17.5 percent and Asians at 42.2 percent (Snyder & Dillow, 2012). The numbers are even more disparaging for SAT math scores in 2012. The average SAT math score for all students was 514 compared to African Americans (428), Puerto Ricans (452), Mexican Americans (465), and American Indian/Alaska Native (489) according to the National Action Council for Minorities in Engineering, Inc. (Smith, C., Lain, A, & Frehill, L., 2014). Despite the achievement gap for URMs in STEM, state policies are playing a significant role in raising the awareness of STEM fields through curriculum enhancements.

3. LOW ADOPTION OF CS COURSES

Recently more states, as well as non-profit organizations, are advancing computing education. The Education Commission of the States reports that twenty states, up from 14 in 2015, now require high schools to count computer science (CS) courses as math or science credits towards students' high school graduation (Heitin, 2016). Among the twenty states CS fulfills only a math credit in nine, a math or science credit in another nine, and only a science credit in two. Organizations like Project Lead The Way (PLTW) are paving the way for more K-12 students to access real-world, applied learning experiences that empower them to gain the skills they need to thrive in college, career, and beyond. The non-profit organization offers activity-, project-, and problem-based curriculum that scaffolds student learning. As PLTW students' progress through grades K-12, they are empowered to explore career paths,

engage in problem solving and process thinking, develop technical knowledge and skills, and build communication skills. PLTW Computer Science (one of five programs launched by PLTW) empowers students in grades 9-12 to become creators, instead of merely consumers, of the technology all around them. The curriculum prepares students for careers in science and engineering (Tai, 2012). High school is the place where many students chose their career field per a study by the National Research Council (2009). But, with state mandates in place there is still no guarantee that universities will accept the math and science credits for admissions. Once admitted, persistence towards earning Bachelor's degrees in STEM fields becomes a challenge, particularly for URMs.

3. LOW ENGINEERING DEGREE COMPLETION

Despite curriculum interventions at the secondary level, URM degree completion rates are lower than non-minority students. Smith, Lain, and Frehill (2013) conducted a longitudinal study of first year college students majoring in engineering, computer science, or engineering technology in the 2003-04 school year using the National Center for Education Statistics PowerStats of June 2011. After six years of tracking the first-year college students, degree completion rates for African Americans (31.2 percent) and Latinos (52.3 percent) were lower than Whites (63.7 percent) and Asians (72.8 percent). In 2011 the total number of engineering bachelor's degrees was 12.47 percent for all URMs, and 2.94 percent for URM females. African Americans represent 12.3 percent (2012) of the U.S. population, yet earn four percent (2012) of the undergraduate engineering degrees (Smith, 2014). Similarly, Latinos represent 17 percent (2012) of the U.S. population and earn 8.6 percent (2011) of the undergraduate degrees in engineering (Smith, 2014).

3.1 U.S. Top Producers

The top producers of B.S. engineering degrees in 2011 for African Americans and Hispanics were North Carolina A&T State University (142) and the University of Puerto Rico Mayaguez (502), respectively. These institutions have demonstrated success in recruiting and graduating URMs by developing an environment that supports diversity and recognizes the academic achievement of all students (Smith, Lain, & Frehill, 2013).

3.2 ABET Accredited Engineering Programs

Currently, there are 609 institutions with ABET (Accreditation Board for Engineering and Technology, Inc.) accredited engineering programs in the U.S. ABET is the recognized U.S. accreditor of college and university programs in applied science, computing, engineering, and technology. According to the 2012 National Science Board's Science and Engineering Indicators only 9.3 percent of Latino students, 7.4 percent of African American students, and 5.6 percent of American Indian/Alaska Native students planned on majoring in engineering in 2010. Tai (2012) analyzed a study by the National Center for Education Statistics that revealed 8th graders were two to three times more likely to earn STEM degrees a decade later when they expressed an interest in a science-related field. An increase in engineering degree completions for URMs in STEM can drive U.S. global competitiveness.

4. CURATED PATHWAYS TO INNOVATON^{TM}: A STEM+C SOLUTION

Per the Bureau of Labor Statistics, employment of computer and information technology occupations is projected to grow 12 percent from 2014-2024, faster than the average for all occupations (U.S Bureau of Labor and Statistics). The U.S. Department of Labor projects 1.1 million computing job openings by 2024 and an insufficiency of qualified American students to meet the workforce needs (National Center for Women & Information Technology). This is a problem for U.S. competitiveness. Today, white men earn 70 percent of the computing degrees in the U.S., yet they make up only 30 percent of the population (Computer Research Association). Clearly, the U.S. needs women and underrepresented minorities (URMs) to meet national computing workforce demands.

4.1 A View of Silicon Valley

The critical need to solve the broadening participation (BP) challenge is brought into sharp focus in Silicon Valley (SV), home to 46 percent of the U.S. venture capital investments, and where innovation industries generate roughly 33 percent of the region's annual output (Silicon Valley Community Foundation & Silicon Valley Leadership Group, 2015). In California, there are anticipated to be 19,750 annual average openings in 2020, but only 9,939 annual degrees in computer and information sciences earned (U.S. Department of Labor, 2012-2022; Institute of Education Science National Center Education

Statistics, 2012-2013). Sustained job growth means significant demand. However, the problem is not solely a pipeline issue. The demographics in SV tech companies do not mirror the diversity of the state's workforce. In 2010, the California workforce was 34 percent Hispanic, yet the top 10 largest SV tech companies were six percent Hispanic (U.S. Census Bureau). Silicon Valley is failing to develop, recruit, and hire its own diverse tech talent. This lack of diversity leads to biases in the products and technologies that are developed. For example, the initial release of Apple's health app didn't include a feature for women to track their menstruation cycles (Cooney, 2016) and Google's photo app was classifying images of black people as gorillas (BBC 2015). This lack of features led to oversight of key market opportunities and excluded key populations in utilizing the features.

4.2 Lack of Longitudinal Studies in CS

Many groups have developed programs to address the tech diversity BP problem by increasing the opportunity for women and URMs to engage with computer science. However, no longitudinal studies have been completed to understand which of the interventions, such as coding camps or hack-a-thons, have a long-term positive impact. Many programs appear to be ineffective, since of the 40,000 Bachelor of Science computing degrees conferred in 2013 in the U.S., only 18 percent were women, a dramatic drop from 37 percent in 1984 (IEC NCES, 2013). While some of the offered programs are certainly successful in exciting, engaging and preparing women and URMs for careers in computer science, they only address one to two phases of developing life experiences and do not connect or aggregate resources. There is currently no method to guide and incentivize people along a personalized, linked set of proven interventions that lead to evidence-based success on the journey from school to career.

4.3 The Silicon Valley-Based Pilot

The Curated Pathways to Innovation™ [CP™] is a web-based application that guides and incentivizes students' success through gamification, analytics, and a recommendation algorithm. Essentially, a 'virtual guidance counselor.' CPI™ pilot project, led by a consortium of partners, will address the BP challenge of creating cradle-to-career (pre- K-20+) pathways in the Silicon Valley area by aligning efforts of tech industry leaders, universities, colleges, non-profits, schools, and surrounding communities. The SV pilot will: (1) develop, and build capacity to strengthen the **CPI™ collective impact structure**; (2) cultivate SV CPI™ **partnerships**; (3) develop **innovative methodology** to provide proven, personalized resources; (4) design scaling strategy and identify **networks to affect national change** in computing first, and then in all STEM disciplines. The SV CPI™ project will recruit, retain, positively impact behavior, and help young girls, women, and URMs overcome obstacles to succeed at becoming members of the computing workforce. A consortium of partners, each of which will be recommended for their effective programs and cooperating in an ecosystem, has the potential to scale throughout the state of California and beyond based on the collective impact model.

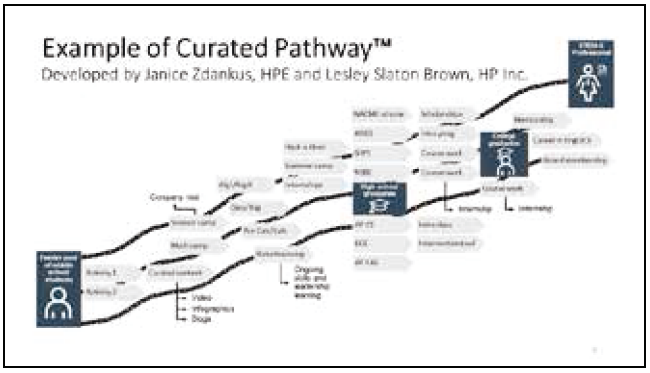


Figure 1.0 – Example of Curated Pathways to Innovation™

4.4. CPI™ Research Goals

The research goals of the pilot phase include establishing a longitudinal, attitudinal, and behavioral study. A new technology application will serve as the interface to collect individual data and provide a personalized set of incentivized engagement interventions. The outcomes of the student engagements will be measured. Through a machine-learning process, the outcomes will be used to inform the development of personalized pathways. Over time, survey data and measured outcomes from users will continue to improve the recommendation algorithm and quality of the personalized pathways.

4.5 CPI™ Partnerships

A complex system of partnerships is necessary to weave together a support system from cradle to career. The CPI™ network plans to use a collective impact framework (Kania & Kramer, 2011) to introduce and support novel technology to achieve our goals. The CPI™ leadership team brings diverse expertise and connections with academia, industry, government agencies, and community-based

organizations. The team is poised to oversee the various aspects of the pilot project, facilitate the regional and national scale-up, and retain oversight and management of the final CPI™ network. Partnership MOU's and financial agreements are in place for the leadership team and their respective institutions/organizations, as well as the pilot site at Ocala Science Technology Engineering and Arts (STEAM) Academy.

5. IMPORTANCE OF THE PROBLEM

Without the shoring-up of scientific disciplines, the United States will continue to lag among its global competitors, which is why it is important to address this problem. The 1957 launch of Sputnik, the Russians' first artificial Earth satellite into space, sparked a sense of urgency in the United States. Since then it became urgent for the U.S. to invest in mathematics and science education to remain globally competitive (Galama & Hosek, 2008).

5.1 U.S. Global Competitiveness

However, the U.S. currently lags China in the production of engineering degrees conferred by about 130,000 annually (Anderson & Dongbin, 2006). The demand for engineers far exceeds the supply of engineers. Dr. S. Jackson, President of Rensselaer Polytechnic Institute, refers to this as "the 'quiet crisis,' because this deficit of talent will cripple our national–even the international–capacity for discovery, for innovation, for meeting the world's human and economic needs" (Slaughter, Tao, & Pearson, 2015, p. 3). In the 1990s colleges and universities were urged by Dr. Jackson to accommodate URMs in STEM fields (Slaughter, Tao, & Pearson, 2015).

5.2 Need for A Diverse Workforce

Other national leaders expressed a similar sense of urgency. In his October 4, 1998 address at the annual National Academy of Engineering meeting, President W. A. Wulf, gave reasons why the U.S. requires a diverse workforce. Since engineering is a creative profession, people bring their life experiences to what they do, resulting in maximum opportunity cost. This practice removes the barriers to understanding, design, building, and inventions. Diversity of thought contributes to better products and services from corporations, schools, and societies (Page, 2008). The future of the United States' global competitiveness depends on closing the gap of STEM degrees granted to URMs.

5.3 Failure to Tap into Diverse Groups

Yet, the nation has failed to fully tap into the potential of filling this gap, especially since Hispanics are the fastest growing population. By the year 2050 the Hispanic population is projected to grow to 26.8 percent of the U.S. population, up from 12 percent in 2012 (Smith, Lain, & Frehill, 2013). In addition, the low numbers of STEM degrees earned by URMs impacts the demand to fill nearly five million STEM occupations from retiring baby boomers, that is, those born between 1946-1964 (Carnevale, Smith, & Melton, 2013). The lack of diversity in STEM education has an impact on the STEM degrees granted to URMs, which in turn, impacts the STEM workforce. In 2010 only 10.9 percent of the engineering workforce was comprised of the URMs compared to 6.3 percent in 1999. Of the 1,708,700 engineers in the workforce, 2.6 percent were African Americans, 3.4 percent were Latinos, and 0.3 percent were American Indian in 1999. The total number of engineers in the workforce declined to 1,475,510 in 2010, while African Americans, Latinos, and American Indians rose to 5.2, 5.4, and 0.3 percent respectively (Smith, Lain, & Frehill, 2013). Should this trajectory continue, further research is needed to determine the best and promising practices for recruitment of URMs into the STEM workforce.

6. ACKNOWLEDGMENTS

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NOTES

2-YEAR INSTITUTIONS: LATINO STUDENT SUCCESS IN STEM

Moderator: Elsa Villa, University of Texas at El Paso
Panelists: James Dorsey, Washington MESA/MESA USA
Shirley Malcom, American Association for the Advancement of Science
Leticia Oseguera, Pennsylvania State University

Research has suggested that a large majority of Latinas/os begin their path to higher education at 2-year colleges. This is at least in part a buffer against financial strain as well as to remain close to their families for moral support and to help meet family responsibilities. Although more Latinas/os are entering higher education than ever before through community college pathways, relatively few are transferring from 2-year to 4-year institutions, and they are still one of the most underrepresented groups graduating with 4 year degrees in STEM.

This panel addresses mechanisms for increasing transfer rates of Latina/o students interested in pursuing STEM, for example, through articulation agreements and partnerships between 2-year and 4 year institutions. It also considers how to maintain those students after transfer through family outreach, student engagement in research, and culturally welcoming climates on campus.

MESA Community College Program: A Mixed Methods Study of a Promising Program to Increase Diversity in STEM Higher Education

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ABSTRACT

Despite the large and growing gap in diversity[1] in STEM higher education and employment, few studies have described and evaluated individual programs aimed to address the equity gap in STEM[2] higher education, particularly programs aimed specifically at supporting diverse community college students who are pursuing STEM fields. This mixed methods study investigates one such program, The MESA (Math Engineering Science Achievement) Community College Program (MCCP) in six colleges in two states, examining student experiences via focus groups and statistical data analysis. The study finds that there is at least suggestive evidence that MCCP may produce impressive results in a field of great policy interest. When compared against students who also showed transfer intent in a STEM field MESA students accumulated significantly more college level credits, more STEM credits, and graduated with a transfer degree at significantly higher rates. Students in focus groups attributed program success to the community, academic and social integration, academic support, career and professional development activities with diverse mentors and targeted academic advising they received through MESA, activities that have also been found to be important in previous studies.

1. INTRODUCTION

Scholars, policymakers and business leaders have pointed to the lack of diversity and equity in STEM fields as a large and growing economic and moral concern. To reach larger and more diverse populations of potential STEM students, community colleges have been recognized for their potential. "Community colleges are uniquely positioned to grow the pipeline of STEM professionals and produce more STEM-skilled workers to meet the demand for middle and high skill jobs" (National Governors Association, 2011). In fall 2014, 42 percent of all undergraduate students in the United States attended community colleges. (College Board, Trends in Community Colleges, 2016). In 2012–2013, 10.1 million undergraduates were enrolled in public two-year colleges (NCES, Digest of Education Statistics 2014, Table 308.10).

Not only are they large in size, community colleges are also accessible for diverse students who often access them as a first point of entry into the higher education system. Forty-four percent of low-income students (those with family incomes of less than $25,000 per year) attend community colleges as their first college after high school; by comparison, only 15 percent of high-income students enroll in community colleges initially (Ingels et. al, 2014). They also serve more first-generation students and are more diverse than four-year institutions (Ingels et. al, 2014).

[1] This research is supported by grant #1304776 from the National Science Foundation (NSF) Education & Human Resource (EHR) through the Louis Stokes Alliance for Minority Participation (LS AMP).

[2] James Dorsey is project PI, President of MESA USA and Executive Director of Washington MESA; Erik Jones PI (2013-2016); is the former Associated AD of Research and Technology of Washington MESA and current Chief Information Officer the University of Washington Athletics; Elizabeth Meza, PhD, is a Research Scientist and a Special Assistant – Researcher in the Washington MESA Office at the University of Washington. William Zumeta is Professor in the Evans School of Public Policy and Government, University of Washington., Dr. Phyllis Harvey-Buschel is Director of MESA K-12 programs, Lucy Casale is Sr. Associate Director Washington MESA and Statewide MESA Community College Director.

Previous research has found "key factors" predicting success include pre-college preparation in the sciences, teacher encouragement, developing intrinsic motivation, and maintaining perseverance (Russel & Atwater, 2005). Also found to be important in previous research are family support, especially for Latino students– (Cole & Espinosa, 2008; Russel & Atwater, 2005), undergraduate research opportunities (Chang, Sharkness, Hurtado & Newman, 2014), and advising to clarify school or career plans (Hurtado, Cabrera, Lin, Arellano & Espinosa, 2009). Students also appear to persist and transfer when they think of themselves and others (e.g. faculty) recognize them as "science people" (Carlone & Johnson, 2007), and when they consider science as an important part of their self-identity (Chang, et al. 2011; Espinosa, 2011). A welcoming campus racial climate is also important (Hurtado et al. 2011) as is aspiring to attain a graduate degree (Chang et al. 2008). Finally, other researchers have found that elements of social engagement, such as joining a club or participating in science activities (Chang et al. 2008; Chang et al. 2014) and studying frequently with others (Chang et al., 2014) encourage STEM students, and particularly URM and first generation students, to persist and transfer.

2. MESA COMMUNITY COLLEGE PROGRAM

While research has identified important factors in facilitating STEM persistence and transfer for diverse populations, few studies have investigated specific programs for efficacy in facilitating underrepresented student success in STEM, and even fewer have investigated such programs at community colleges. This study investigates the Math Engineering Science Achievement (MESA) Community College Program (MCCP) was developed and now operates in 35 California community colleges, six Washington community colleges, and in many colleges in other states. This research centers on the six MCCP colleges in Washington and two additional colleges in California. The MESA program includes nearly all components that researchers have found to be important for student success. The main program components include:

- **Academic Excellence Workshops (AEW)**
  Students are scheduled in the same core math and science classes and receive additional formal tutoring sessions from a peer tutor or faculty member through a collaborative approach.
- **Orientation course**
- **Academic advising/counseling**
- **Student study center**
  Each campus provides a dedicated multipurpose space that is the hub for study, workshops, special activities, and information sharing.
- **Assistance in the transfer process**
- **Career development**
- **Links with student and professional organizations**
- **Professional development**
- **Dedicated MESA director**

Students with STEM interests voluntarily enroll in MESA and must be an underrepresented minority, a woman in science, engineering or math (excluding nursing), and/or a first-generation college student to participate. Funding for MESA programs is provided by state legislatures and grants. Some additional funds are provided by host colleges.

2.1 Research Questions

In an effort to better understand the outcomes of MCCP, the Washington state MESA office housed at the University of Washington applied for and was awarded a National Science Foundation (NSF) grant to investigate the influence of MESA Community College Programming on student self-efficacy, interest, perception, and persistence in STEM courses and majors. Three research questions addressed in this study are *Q1: What influences do MESA Community College Program (MCCP) activities have on students' STEM self-efficacy? Q2: How are students' interests and perceptions of STEM influenced by participation in MCCP activities? Q3: What influences do MCCP activities have on students' persistence and completion of degrees?*

2.2 Study Methodology

A simultaneous mixed methods approach was taken based on the research questions. The first two research questions are answered by reporting the findings from qualitative interviews with program administrators and focus groups with students. The third research question is answered through linear and logistic regression analysis of data obtained from the Washington State Board of Community and Technical Colleges wherein MESA students are compared on these outcomes with other STEM transfer intent students in this state system, controlling for student background characteristics.

Colleges represented in this study include every college with a MCCP program in Washington (six

colleges) and two additional colleges in California. Colleges were purposefully selected because the principal researcher could verify that the program included each "core component" of the MCCP model described earlier and programs selected had reached maturity, thereby avoiding the pitfall of documenting implementation challenges rather than programs at full-implementation. Because of data incomparability between the two states due to differences in data collection, variables, and access, we only include the six colleges in Washington in the quantitative data analyses related to research question three.

2.3 Focus Group Findings

Student focus group participants included 73 students in six colleges. Colleges are diverse in terms of their size, location (urban, suburban and rural campuses were represented) and demographics.

Several themes emerged including 1) the success of the MESA model in building community through academic and social engagement and integration with college courses and activities; 2) the importance of a dedicated and welcoming study space for academic and social support and creation of community; 3) the value of technically and academically competent peer-tutors and workshop facilitators; 4) presence of caring and dedicated staff; 5) the value of career and professional development activities where students can meet and interact with diverse STEM professionals; and, finally, 6) students found important and motivating the "prestige" and "rigor" that MESA provides.

2.3.1 Inclusive social and academic community

One word that was mentioned more than any other and that emerged in nearly every student answer was the success of the MESA model in creating an *inclusive community* for this diverse group of students. A student identifying himself as an underrepresented minority said, "this place brings together people looking to help each other get through courses, people who could use a little more help, it's like an outlet to get information to succeed." Previous studies have also found that joining student clubs and organizations and the creation of community specifically around academic content are important for student success in STEM, particularly for underrepresented minority success (Chang et al 2014).

In fact, the dedicated study space reserved exclusively for MESA students was hailed by students as key to MESA programming and also to their own academic success. Students indicated that, "Support and group study are the most important, this place [the study center] is comfortable and supportive, we are a big family." Campus study centers varied from small classrooms or large office suites to large open spaces surrounded by smaller rooms that students could reserve.

One campus of the six visited provides an instructive contrast to the rest of the centers. At a large, suburban, and diverse community college in Washington, college administrators saw the benefits of the MESA program and decided to allocate additional funds so that all students interested in STEM (not just the URM and first-generation students MESA traditionally serves) would be able to receive services. They enlarged and opened up the MESA center to all interested STEM students who were dubbed ASEM (Achievement Science Engineering Math) students. However, this well-intentioned program expanded so that any student on campus with a STEM interest could join appears to have diluted the community cohesion felt by the MESA students and lessened program utility and ultimately value for MESA students. The director reported difficulty in getting students to participate in activities and students reported they used the center for tutoring but did not feel the community connection reported at other campuses. It seems the exclusivity of MESA is important – where the safe space of shared community for MESA students can lessen the negative effects of URM and first generation status.

In contrast, students at a large, urban community college in California reported a strong sense of community in their MESA-exclusive space encouraged by welcoming staff with high expectations. Students are required to attend at least four MESA activities each semester. Students described how there were strict requirements to remain in good standing in MESA and felt that the high expectations for program participation encouraged them to get the most out of their studies and provided a real sense of belonging to a special organization.

2.3.2 Quality tutoring

Students felt that the professionalized and knowledgeable tutoring staff members made MESA programming and coming to the MESA center especially valuable in helping them pass their courses and grasp course content. In every site visited students indicated they much preferred attending the more formal Academic Excellence Workshops and less

formal peer tutoring sessions or appointments in the MESA center as opposed to receiving tutoring in campus-wide tutoring centers. At one campus, students both laid out the menu of options and agreed, "the general tutoring is awful, the Math Center is hit and miss, the STEM Center is okay but this place [The MESA study center] is definitely the best." Tutors and workshop leaders in MESA centers are selected by the program directors and students felt both had better teaching skills, a more thorough grasp of course material and better training than more general campus tutors. In several of the centers visited tutors were either faculty members or professional staff with degrees in science or math as opposed to peer tutors more common in community college general campus tutoring centers. Many students said that they didn't consider services in general campus settings to be as specialized or helpful as the course help they received in the MESA centers.

2.3.3 Professional development

Career and professional development opportunities, particularly those with mentoring from diverse professionals, had a large influence on students' motivation and belief in their ability to achieve a degree. "Leadership retreats with minority speakers are very inspirational, it makes you think that minorities can succeed," said one student. This was a common theme, another student said that success in a STEM field was, "far away land before, an impossible goal, and now I feel it's very much possible, more attainable. I am first gen American and my parents never got a proper education and education was only for people who could pay. MESA has shown me that because you're poor and first gen doesn't mean you can't succeed." Much of the continued perseverance students displayed was linked to encouragement from MESA staff and other mentors or professional students had met through MESA events.

2.3.4 Prestige and rigor of program

In addition to the spirit of community and ability to meet diverse professionals who confirmed their career interests, students also found a certain "prestige" or "rigor" in the MESA program itself. Since MCCP students were often studying together and doing well in courses, other students saw their success and reported that, prior to joining MESA, they had the impression it was an honors organization. For these students MESA sponsorship of an event or recommendation of a particular course or faculty member was a signal of rigor and quality.

2.3.5 Caring and dedicated staff

This praise for MCCP services as compared to general campus services continued with regard to advising. Students held in high regard the administrative and advising staff they encountered in MESA. Academic transfer requirements for STEM majors are often complicated and can vary substantially depending on major even within the same discipline or transfer institution. Students found MESA directors and faculty members who acted as advisors for MESA students to be knowledgeable about student ability and confidence level, academic program requirements at a given targeted transfer institution, specific major requirements, and more nuanced issues, for example, which math faculty member might have a teaching style that a given student might enjoy or want to avoid. This type of "high touch" individual advising is not something students found in more general campus advising centers. Students almost uniformly visited MCCP advisors in lieu of campus advisors. MCCP advisors were also able to offer more personalized services, such as helping with university entrance essays or filling out financial aid forms, services students viewed as critical help.

2.3.6 Institutionalization of the program

Unfortunately, students did not always find out about MESA programs easily or through college channels and the level of institutionalization of the centers and programs varied by campus. There was not widespread information about MESA provided in either campus advising sessions or STEM courses. In colleges where MESA did appear to be more institutionalized a strong director and/or faculty with heavy involvement was key. Scholars have written about the importance of "institutional agents" who advocate and champion for URM students on campus and this seems to be one of the functions of the MESA centers (Dowd, Pak, & Bensimon, 2013; Bensimon & Dowd, 2012). A director with visibility among students and credibility among other faculty and staff who had a longstanding history at the college was key to program visibility and institutionalization. On campuses with strong such "agents," students reported higher levels of engagement in MESA activities and higher levels of awareness of the MESA program on campus.

In contrast, several programs visited had experienced multiple director changes and resulting programming gaps. In these colleges students reported having to seek out more information about MESA on their own and to do more legwork to participate in activities.

Where MESA has been institutionalized in college activities, student numbers, student enthusiasm, and robustness of program improves. A strong director or other faculty member who acts as a MESA "institutional agent" is critical for program success.

3. STATISTICAL DATA ANALYSIS

To answer research question 3, "What influences do MCCP activities have on students' persistence and completion of degrees?" Statistical data was analyzed comparing MCCP participants with students who also showed intent to earn a STEM associate's degree. The data set contains a total of 2,744 transfer intent students in Washington who did not participate in MCCP and an additional 488 Washington MCCP participants.[3] Transfer intent students entered one of the community and technical college system colleges (34 total in the state system) in academic year 2011 and indicated that they intended to earn an academic transfer degree and, in addition, attempted at least one STEM course. MCCP participants also entered a community college in academic year 2011 or 2012 and enrolled in MCCP within that time frame, also indicating that they intended to earn a STEM transfer degree. The data set follows the students through Spring quarter 2016, i.e., for 4-5 academic years, and includes student characteristics as well as three outcome variables, total college level credits earned, total STEM credits earned and whether the student earned a transfer associate's degree by Spring 2016.

Unfortunately, there is no variable or data flag in state or college data to indicate whether a student intends to transfer with a STEM degree or focus or major in STEM, which would be desirable to construct the comparison group for the MCCP students. However, researchers at the Washington State Board for Community and Technical Colleges have developed a list of STEM courses. Enrollment in one of these courses was used as a proxy for STEM intent in the non-MCCP sample. These are courses that appear on developmental math and any other prerequisites to enter the courses, so are a plausible comparison group to the MCCP students[4].

Three outcomes variables were examined. First, college level credits earned, second, STEM credits earned, and finally, whether or not a transfer associate's degree earned.

3.1 Descriptive Statistics

Descriptive statistics with no controls indicate that MCCP students earn significantly more college level credits, significantly more STEM credits, and earn associate's transfer degrees at significantly higher rates than non-participants. In addition, zero-order correlations showed that MCCP students were significantly more likely to be Underrepresented Minorities than non-participants. They were also significantly more likely to be female and older than non-participants.

Zero order correlations also showed that age was negatively associated with college level credits and degree but positively associated with STEM credits, while being a female student was positively associated with earning a degree and with college level credits but negatively associated with STEM credits. In other words, MCCP students had stronger outcomes despite the fact that female gender and greater age in general tend to work against success in STEM.

TABLE 1 - Descriptive Statistics of the Three Independent Variables

Measure	Descriptive statistics of the three dependent variables			
	MCCP Participants n= 488		Transfer Intent Students with a STEM course n= 2744	
	M	SD	M	SD
College Level Credits Earned*	80.68	37.46	77.85	39.24

level credits earned, controlling for the variables of age, URM status, and sex. These control variables (TABLE 1) were entered into the model first: with a zero-order correlation of .07, this block of controls accounted for 1% of the variation in college level credits earned, $F(3, 3213) = 6.60$, $R^2_{adjusted} = .01$, $p<.001$. MCCP participation accounted for significant unique variation in college level credits earned once age, URM status, and sex were controlled for, $R^2_{change}=.01$, $F_{change}16.31$, $p<.001$. For this dataset, the model estimate of the intercept showed that predicted college level credits for male students who did not report URM status and did not participate in MCCP was 85.99 credits, $SE=2.98$. Being female increased predicted credits by 4.48, all else equal, while, for every additional year in age, predicted credit accumulation drops by .47. Similarly, URM status students would be expected to earn 3.09 fewer credits than non-URM students. All of these predictors are significantly different from zero, $p<.05$. Again, MCCP membership had a significant and unique positive association with college level credit attainment ($b=7.49$, $SE=1.86$, $t(3391)=4.04$, $p<.001$. **Specifically, therefore we find an estimated mean increase of 7.49 college level credits related to participating in MCCP**, holding all else constant.

The same procedure was repeated for the outcome of STEM credits earned. With a zero-order correlation of .10, the control variables block accounted for 1% of the variation in college level credits earned, $F(3, 3212) = 12.14$, $R^2_{adjusted} = .01$, $p<.001$. MCCP participation accounted for a significant unique variation in STEM credits earned once age, URM status, and sex were controlled, $R^2_{change}=.13$, $F_{change}531.46$, $p<.001$. The model estimate of the intercept predicted STEM credits for male students who did not report URM status and did not participate in MCCP was 24.94 credits, $SE=1.81$. In contrast to all the previous models for college level credits, being female decreased predicted STEM credits by 5.50, while, for every additional year in age, predicted STEM credit accumulation drops by .34. Similarly, URM status students would be expected to earn 5.32 credits less than non-URM students. All of these predictors are significantly different from zero, $p<.001$. Again, MCCP membership had a significant and unique positive association with STEM credit attainment in the multivariate regression, controlling for these variables ($b=25.07$, $SE=1.09$, $t(3212)=23.05$, $p<.001$. **Specifically, there is an estimated mean increase of 25.07 STEM credits related to participating in MCCP**, holding all else constant.

For the dependent variable of whether a transfer associate's degree was earned multiple logistic regression analysis was again used with hierarchical predictors. Somewhat surprisingly, URM status did not uniquely negatively predict whether a student earned a transfer associate's degree, although the coefficient was in the typical negative direction, $b = -.04$ (SE .08), $Wald(1)$ .28, OR = .96. Each year increase in age did uniquely negatively predict whether a student earned a transfer associate's degree, $b = -.03$ (SE .01), $Wald(1)$ 13.32, $p<.001$, OR = .97. Being a female student significantly positively affected this outcome $b = .49$ (SE .07), $Wald(1)$ 47.31, $p<.001$, OR = 1.63. MCCP status accounted for significant unique variation in whether the student earned a transfer associate's degree once the three background characteristic variables were controlled, $b = .78$ (SE .10), $Wald(1)$ 58.47, $p<.001$, OR = 2.19. **The odds ratio indicates that MCCP participants were 2.19 times more likely to graduate with a transfer associate's degree than comparison students who enrolled in a STEM course but who did not participate in MCCP**.

4. CONCLUSION

Readers will no doubt have recognized that MCCP students represented in these data are a motivated and self-selected group who have deliberately chosen to participate in a number of ways. Simply deciding to join the MCCP program, much less filling out a survey and/or participating in a focus group are all marks of dedicated and motivated students. However, MESA students do report that, while they had an interest in STEM before MESA and a strong desire to pursue a transfer degree in STEM, MESA has provided them with additional concrete and intangible resources that have allowed them to persist. The mixed methods nature of this study allows for some triangulation of both the qualitative and quantitative research findings. Despite unavoidable issues with selection bias in the comparisons, there is at least suggestive evidence that MCCP may produce impressive results in a field of great policy interest. Even when compared against students who enrolled in a STEM course (i.e. these students have already passed all developmental math and met all prerequisites for the course), MESA students accumulated significantly more college level credits, more STEM credits, and graduated with a transfer degree at significantly higher rates. This is so in spite

of MESA students having some characteristics that predict lower success rates.

Through focus group research, we found that most MCCP students have a fairly high level of interest in and positive perception of STEM before joining MCCP. The program seems to help them understand more fully the nuances in majors and careers and also boosts their understanding of what major coursework and a career in a particular discipline may entail. Students reported that the community they found in MESA was helpful for them in maintaining their interest in STEM studies.

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Community College Partnerships: Strength-Based Strategies for Latinx Student STEM Success

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ABSTRACT
Training more Latinx students in STEM is important for the success of the U.S. and global economy. This brief advances three strength based areas to consider to improve the experiences of Latinx students in STEM education across 2-4 year partnerships. Training mentors to be better mentors, offering authentic research experiences to develop a deeper understanding of the field and profession, and meaningfully engaging families as advocates in this process are highlighted.

Keywords
Mentors, Undergraduate Research, Family Involvement

1. INTRODUCTION
Latinx are the largest minority group in the nation (16.3 percent, compared to 12.6 percent Black and 4.8 percent Asian) (Ennis, Rios-Vargas, & Albert, 2011) and they are a growing majority across multiple states but despite a numeric increase in college enrollment (Chapa & De La Rosa, 2004), the average cohort of Latinx students in some states actually shows a decrease in the percentage that enrolls in college (Harris & Tienda, 2012). Low Latinx representation in STEM fields is also a concern. Most of the growth in bachelor's degree awarded to Latinx students between 1998 through 2007 were in non-science or engineering fields (Dowd, 2012). This underrepresentation extends through to doctoral degree completion where 5 percent of STEM doctoral degrees are awarded to Latinx yet they represent 15 percent of the population (Dowd, 2012). Less work has been conducted examining the role of transfer for Latina/o STEM students but researchers have determined that transfer pathways from community colleges are limited, that most STEM transfers who end up with a bachelor's degree in STEM earned associate's in non-STEM fields, and that chances of earning a STEM bachelor's degree are actually lower if one earns an associate degree prior to transfer (Dowd, 2012). Clearly, more work to facilitate the successful movement out of the community college and into STEM fields and careers is warranted especially as we know that Latinx students disproportionately begin their studies in a community college.

There are a plethora of factors to consider if we are to improve the success across the 2-4 year pathway of Latinx students in STEM from structural considerations around designing curriculum that reduces time to degree when students move between institutions to minimizing financial barriers. Additional challenges this population of students face include lower socio economic status and parental education, poorer academic preparation, less family involvement, and fewer faculty and mentor interactions Given the brevity of this position paper, I advance three strength based ways to work with Latinx students: mentor training, authentic research experiences, and valued family involvement as critical for 2-4 year college partnerships.

2. MENTORS AND MENTOR TRAINING
We do not achieve success by ourselves. For success in STEM, Latinx students need access to genuine mentoring experiences. Mentorship consists of "a reciprocal, dynamic, relationship between mentor (or mentoring team) and mentee that promotes the satisfaction and/or development of both" (McGee, p. 232, 2016). Quality mentorship should begin at the community college level and extend into the four-year transfer institution and includes peer mentors, advanced graduate student mentors, faculty and staff knowledgeable about STEM careers, as well as industry mentors (see Packard, 2012).

What is critical to this mentoring component, however, is being sensitive and aware of the unconscious (or

conscious) biases and expectations we bring to this mentoring process, hence a need for mentor training. Students often leave STEM because of poor fit and lack of cultural response. Women and underrepresented students who persisted in STEM did so not because there was a demonstrable change in institutional culture but because they sought out extra mentoring and training (Ko, Kachchaf, Hodari, & Ong, 2014). While seeking out mentoring is important, scholars have repeatedly shown that students of color often report limited access to mentoring compared to their white counterparts (Byars-Winston, Branchaw, Pfund, Leverett, & Newton, 2015). Therefore, as we consider mentor training, we should simultaneously identify ways to attract mentors who will serve Latinx students well.

McGee (2016) concludes that mentor training is critical to develop talents and foster success and suggests that mentor training in STEM has exploded and that we now have a "highly sophisticated and rapidly expanding workshop-based approach to developing skills of mentors and promoting effective mentoring relationships" (p. 232). Handelsman and colleagues (2005) and McGee (2016) outline the context that is needed to develop talents and foster success within STEM and advance the training of mentors to bolster STEM success. Effective mentoring not only provides the day to day of what is expected but encourages mentors to also be mindful of the messages they send in this process. Acknowledging and minimizing (or eliminating) the bias and stereotyping that can interrupt successful mentoring processes is an important ingredient to a successful mentoring relationship. I advance this as a strength based perspective because we remove the sole onus of success on the student and we also acknowledge the work needed to be a better mentor. Mentoring matters. For further guidance, see Pfund and colleagues' (2016) comprehensive work aimed at developing more effective research mentoring relationships within STEM.

3. AUTHENTIC UNDERGRADUATE RESEARCH EXPERIENCES

A second factor to consider in the success of Latinx students in STEM is the use of authentic STEM experiences that have been shown to be effective at maintaining interests in STEM and predictive of degree completion. One such experience is undergraduate research and in the context of 2-4 year partnerships, beginning research while still enrolled as a community college student. These undergraduate research experiences are especially important for underrepresented groups as they strengthen these students' identities as scientists or engineers and undergraduate research provides pathways into research-related career pathways for underrepresented groups (Eagan, Hurtado, Chang, Garcia, Herrera, & Garibay, 2013; Gregerman, Lerner, von Hippel, Jonides, & Nagda, 1998; Hathaway, Nagda, & Gregerman, 2002). Engaging students early as to what research entails can be important for continued success in STEM. Early undergraduate research experiences matter for retention, persistence, and are consistently shown to be one of the strongest predictors of success including STEM graduate school enrollment. In fact, one of the hallmarks of the success of STEM programs such as the Meyerhoff Scholars Program include student engagement in research labs within the first two years of study. Successful programs operating in the community college level which partner with four-year colleges and universities to provide research experiences are ideal as relationships between community colleges and research universities can enhance the availability and quality of research experiences for students at community colleges (Shaffer et al., 2010; Wei & Woodin, 2011).

4. FAMILIES AS PARTNERS

The third area I focus on is intentional and meaningful family involvement. The literature has long advanced that parents and families should be involved in the college process of Latinx students. Parental support has been identified as one way to buffer against stigmatized environments (Chang, Eagan, Lin, & Hurtado, 2011). But what does authentic, non-superficial family participation look like? One promising program is: Padres Promotores de la Educación [Parents as Promoters of Education]. While not exclusively focused on STEM education, the 16 year old program Padres Promotores de la Educación has proven successful in engaging parents/families in the process of college planning and college success. Padres Promotores has evolved from a grassroots organization to one that has a permanent office on a community college campus and has established a curriculum and training program and hosts events, both traditional and non-traditional, and uses families as the messenger to encourage college success. In other words, parents train other parents and are valued partners in this process.

For asset based projects, one should consider how the families of the students are actively engaged. Informing families and bringing them along the journey is an important ingredient to Latinx success and the Padres Promotores model is an example of how to capitalize on the strengths between families, communities, local industry, middle/high schools, community colleges, and comprehensive state universities and public research universities.

5. CONCLUSION

Training more Latinx students in STEM is important for the success of the U.S. and global economy. This brief highlights three strength based areas to consider to improve the experiences of Latinx students in STEM across 2-4 year partnerships. That is, training mentors to be better mentors, offering authentic research experiences to develop a deeper understanding of the field and profession, and meaningfully engaging families as advocates are important ingredients in this process. For additional information on the elements needed to ensure 2-4 year partnerships work effectively and viable 2-4 year STEM partnership models see Dowd (2012) and National Academies of Science, Engineering, and Medicine (2016). The charge moving forward is how to have a collective impact around Latinx and other underrepresented groups' STEM success.

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CAHSI-INCLUDES Relevant Scholarship for 2-4 Year Partnerships Panel

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ABSTRACT

A significant body of literature exists on community colleges and their role in transition of students to 4-year institutions. The literature addresses both the challenges and opportunities afforded students who attend 2-year institutions a nd the reasons they do, or do not, successfully transfer to complete their baccalaureate degrees. To address challenges and opportunities in institutions of higher education, this paper also discusses education research literature informing the creation and sustainability of inclusive cultures in higher education, generally; and, specifically, understanding why particular programs advance, or hinder, the trajectories of non-traditional students who are largely underrepresented in STEM fields. Understanding how such inclusive environments can be optimized has potential to advance the mission of the NSF INCLUDES program with its aim of broadening participation of underrepresented minorities in STEM.

Keywords

Community college, community college transfer, student identity, minorities in STEM

1. INTRODUCTION

The need for broadening the participation of underrepresented minorities in STEM is well documented. However, increases in baccalaureate degree production in STEM have been minimal at best, which is the impetus behind the NSF INCLUDES program with its promising production of national alliances coordinated in such a way to produce collective impact in broadening participation of underrepresented minorities in STEM fields, in particular Latina/os.

One area of emphasis is the role of community colleges in transferring more STEM majors into 4-year institutions. Since Latina/o students are more likely to begin their undergraduate studies at a community college[1,2] and are more likely to be first in their families to attend college[3,4], community college partnerships with 4-year institutions have strong potential for broadening participation of Latina/os in computational science. Pérez and Ceja[2] cite various factors that make community colleges more attractive to students. These factors include convenience of location, open accessibility, lower cost, and diversity of students. In California, for example, the vast majority (~75%) of college going students in public institutions of higher education are in a community college yet under 20% attend an institution in one of the California university systems[5].

Further, while 85% of community college students nationwide intend to transfer to a four-year institution, only 25% actually do so[6]. This is corroborated by a California longitudinal study[7] finding that only 17% of Latino/as actually transferred to a 4-year institution compared to 31% of White students.

2. LITERATURE ON COMMUNITY COLLEGE TRANSFER

Various studies have identified a few factors to explain why these transfer rates are low. First, Latino/as are more likely to be the first in their family to start college, thus, lacking resources to successfully navigate the system[3,4]. Second, if a student "stops out" due to a family emergency or financial challenges, that student is less likely to return[8]. Third, Latina/os are more likely to need remediation, as evidenced by a study indicating that Hispanics take remedial courses at a much higher rate than their counterparts[9]. If a student is placed into a remedial course, s/he is more likely to not complete the course and more likely to leave college[10,9,11]. Hadden[12] attributed this dropout rate to the stigmatization caused by placement into a low ability course. In sum, more Latinos are in remedial classes than other groups; and, students who take remedial courses are less likely to attain a baccalaureate degree[13].

2.1 Comparison Between Community College Transfer Students and University Students

What is interesting to note is Melguizo, Kienzl, and Alfonso[14] compared success rates of rising juniors who were community college transfers with students who had started their education at a 4-year institution. They found no statistically significant differences between these two populations. That is, community college transfer students attain baccalaureate degrees at the same rate as rising college juniors. However, as already noted, a small percentage of community college students actually transfer to 4-year institutions; and, for minority students, the transfer rate is even lower[4]. This implies more can be done to support students, who are interested in continuing their university studies, in making their transfer successful.

Thus, the role of community colleges is critical and essential for broadening the participation of Latina/os in STEM fields.

2.2 Promising Practices

Rendón[15,16] emphasized the importance of institutional agents to "validate," or affirm, community college students as knowledgeable and valuable members of the academic community. This notion is corroborated by similar studies[11,12].

Further, Martínez and Fernández[18] asserted the importance of relationship-centered institutions that "focus on internal and external collaboration with all stakeholders" (p. 57). Further, having Hispanic faculty at an institution also supports the establishment of a supportive environment for Latino/a students[11]; which is particularly critical if these faculty authentically "care about students" [19] (p. 21.). Further, special programs — such as summer bridge, orientation, and partnership programs — support student transfer through the building of personal relationships and a more welcoming culture[3,8,16].

With the recent surge across the nation in dual credit and dual enrollment[20], another opportunity presents itself for students to accumulate college credits, which studies show contribute to their likelihood of enrolling in a postsecondary institution. Dual credit is a partnership between a postsecondary institution and a school district allowing students to take college coursework that counts for both high school graduation requirements and college transfer credits; and dual enrollment is co-enrollment in both high school and college wherein students accumulate college credits while in high school. In a recent study, Andrews[21] found the following opportunities for dual enrollment/dual credit: gain technical skills not offered in high school and/or earn up to two semesters of college credits prior to high school graduation.

3. RESEARCH INFORMING PRACTICE

A variety of programs exist to remedy the challenges Latina/o students face while pursuing degrees in higher education. This panel will present in part some of these successful programs. To better understand why any particular program succeeds or fails, or why some students benefit while others do not, it is important to understand the theoretical underpinnings of participation in social settings.

Literature over the past decade has shown that identity is increasingly becoming a core issue in the study of teaching and learning, generally, and in science education, specifically[22,23,24,25]. That is, we learn values, language, knowledge and skills situated in everyday practice with others and with artifacts; and what we learn creates a sense of self and identity—who we are for ourselves and in relation to others[26,27]. As human beings, we inherently make sense of our world in unconscious and tacit ways through our interaction with others and our environment as we engage in authentic and situated activity. In this framework, identities are constructed in social practices and are in continuous flux depending on any particular situation, such as whether an individual is in a welcoming environment or in an environment where an individual senses her/himself as an outsider. Thus, learning occurs in social contexts and develops our identity, such as a student who is good in math, a child who is loved by her/his parents, and/or a friend who is trusted and is trusting. It can also negatively affect our identity, such as a student who is not good at math, a child who is abused by parents and feels unloved, and/or a friend who cannot be trusted.

Thus, the design of environments in STEM programs influences how particular positive, or negative, identities will be formed by its participants. These programs then are important as they have potential to create the kinds of identities that reflect positive connections to STEM disciplines and careers. If stakeholders and other participants in promising models, programs, and practices take particular heed to what the research and relevant literature reveal, the likelihood of advancing diverse students from pre-college through college-level programs is high and has potential to dramatically change the landscape of STEM participation.

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NOTES

UNDERGRADUATE DEGREES: INCREASING LATINO RETENTION AND COMPLETION

Moderator: Ann Q. Gates, University of Texas El Paso
Panelists: Juan Meza, University of California, Merced
Phillip Loya, Code 2040
Heather Thiry, University of Colorado

Higher education researchers have highlighted the social, cultural, and financial barriers that have impeded Latina/o postsecondary degree completion; more research is needed, however, to fully understand the factors that support degree completion of Latinas/os in STEM. Some research has pointed to the cultural incongruence between minority communities and academic STEM departments. HSIs may potentially lessen the impact of cultural incongruence and have been touted as important access points for Latinas/os in STEM.

This panel focuses on student success factors and the conditions under which evidence-based reforms can be adopted and sustained. In particular, panelists will be asked to identify the critical elements to enhance the success of diverse student populations inside and outside the classroom and the consideration of institutional and cultural differences.

The CAHSI INCLUDES Collective Impact Initiative

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ABSTRACT

The Computing Alliance of Hispanic-Serving Institutions (CAHSI) serves as the lead partner and mini-backbone for the INCLUDES Alliance for broadening participation in computation-based STEM graduate studies. CAHSI, funded since 2006 through the NSF Broadening Participation in Computing program, has an established consortium of 15 institutions and private/public sector collaborations across the U.S. and Puerto Rico with an effective organizational model for sharing and implementing evidence-based practices. With a mere 4% STEM Master's and 3% STEM doctorate degrees awarded nationwide to Hispanics in 2012-2013, the desperate need to reach parity is clear. The CAHSI INCLUDES Alliance extends CAHSI to include 2-year colleges and other partners. This paper provides an overview of existing efforts. More importantly, it challenges the broad community to reflect on its own efforts to reach parity across all academic pathways and take action as a collective.

Keywords

CAHSI, broadening participation, student success, Latino recruitment, retention, and advancement

1. INTRODUCTION

To ensure our nation's economic and social health, it is imperative that the U.S. maintain a globally competitive computing workforce by expanding its engagement of Hispanics, the nation's largest minority group. Hispanic-Serving Institutions (HSIs) enroll almost half of Hispanic students attending college (Conrad & Gasman, 2015), yet HSIs represent less than 6% of postsecondary institutions in the U.S. According to Excelencia in Education (2015), 7% of Science, Technology, Engineering, and Mathematics (STEM) baccalaureate degrees were earned by Hispanics in 2013, and a mere 4% and 3% were master's and doctoral STEM degrees, respectively. The Computing Alliance of Hispanic-Serving Institutions (CAHSI) (Gates, Hug, & Thiry, 2016; Gates, Hug, Thiry, Alo, Beheshti, Fernandez, Rodriguez & Adjouadi, 2011) was formed in 2004 with the core purpose of creating a unified voice to consolidate the strengths and resources of HSIs and other groups committed to increasing the number of Hispanics in all computing areas. CAHSI founding institutions include: California State University-Dominguez Hills (CSU-DH), Florida International University (FIU), New Mexico State University (NMSU), Texas A&M University-Corpus Christi (TAMU-CC), University of Houston Downtown (UHD), University of Puerto Rico Mayaguez (UPRM), and University of Texas at El Paso (UTEP).

CAHSI now works with over fifteen universities and colleges in California, Texas, New Mexico, Illinois, Florida, and Puerto Rico. CAHSI mainstreams mentoring and the building of structured, academic networks for students that prepare them for success in coursework from entry level through graduate school and thereafter into the STEM workforce. CAHSI students' backgrounds reflect trends across the nation of undergraduate populations increasingly beginning their studies in community colleges, more likely to be ethnically diverse, and working to a greater extent to support their educational pathways (Kurlaender, 2006; Pérez & Ceja, 2010). Economic hardships cause almost a quarter of CAHSI students to stop out, i.e., suspend their studies (Moore & Shulock, 2007).

CAHSI has built a pedagogical and intellectual community to support student success and has created the human infrastructure to support its initiatives by training faculty in effective practices. **CAHSI's goals** have remained constant since its inception: (1) increase the number of Hispanic students who enter the computing workforce with advanced degrees; (2) support the retention and advancement of Hispanic students and faculty in computing; and (3) develop and sustain competitive education and research programs.

Recognizing the need to accelerate the change in the number of Hispanics who enter graduate studies in computation-based fields, such as computer science, computer engineering, computational science, data science, statistics, and geophysics, CAHSI is serving as the mini-backbone to an NSF INCLUDES pilot. The **CAHSI INCLUDES goal** is to accelerate the number of students entering, persisting in the major,

and considering and entering graduate studies in computation-based majors by building student identify, student belonging, advocacy, and preparation. The **focus** of the proposed pilot is on targeting the pool of talented students at HSIs who, for various reasons, do not choose to continue on STEM educational and career pathways. Thus, we target various academic junctures as shown in Fig. 1, including transferring from a 2-year college to a 4-year college (and vice versa) and continuation from a baccalaureate to a graduate program. The inclusion of two-year colleges, 4-year colleges, and research universities in the networked community provides the capacity and, with the consideration of culture and infrastructure, provides intentional pathways for Hispanics to enter the STEM workforce and to continue their education at various points in their work-educational lifecycle. The brown rectangles and arrows in Fig. 1 shows the broad categories of initiatives that have been identified across the CAHSI INCLUDES alliance. CAHSI INCLUDES aims to pursue its goal through networked partnerships across regions of the U.S. with significant Hispanic populations, partnerships that collectively adopt and adapt proven practices and apply them throughout the higher education system of 2-year colleges and baccalaureate-, master's-, and doctorate-granting universities.

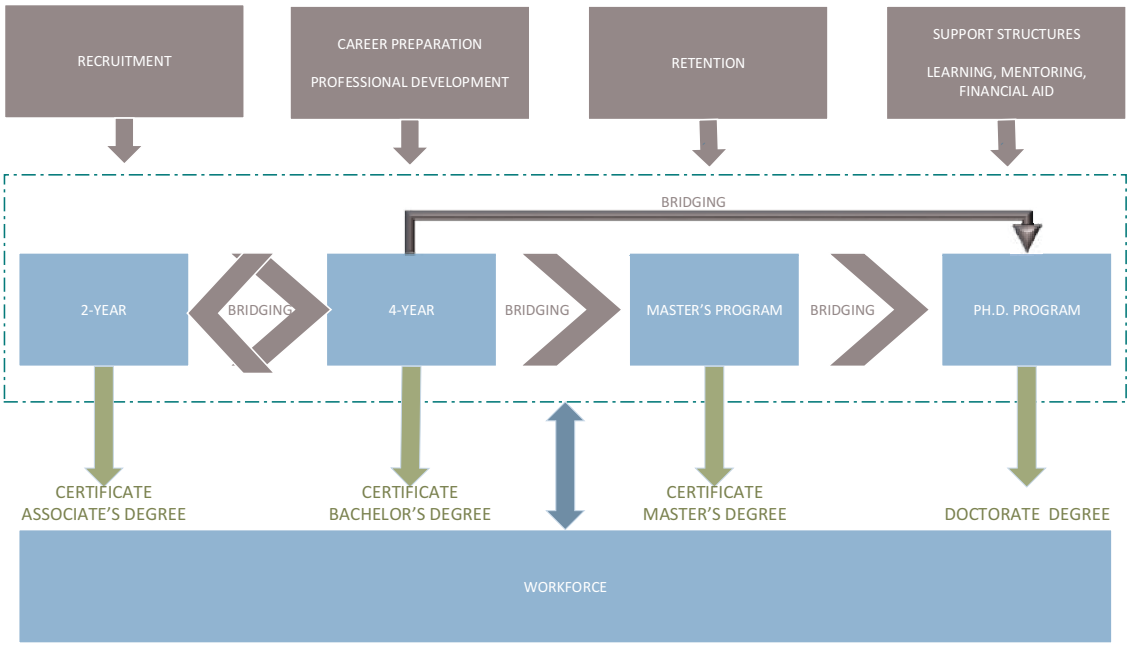


Figure 1: The scope of the CAHSI INCLUDES pilot.

At its first convening, the CAHSI INCLUDES alliance involved representatives from CSU-DH, CSU-Stanislaus (CSU-Stan), Code 2040, Doña Ana Community College (DACC) Fresno State University (FSU), Google, Hewlett Packard Enterprise, Merced College (MC), NMSU, NMSU Alamogordo (NMSU-A), Prudential, University of California Merced (UC Merced), UTEP, and the YWCA.

2. COLLECTIVE IMPACT

As a collective impact initiative, the CAHSI INCLUDES alliance is driven by a core purpose centered on sustaining a unified effort that consolidates the strengths and resources of HSIs, non-profits, public and private entities committed to increasing the number of Hispanics in all computation-based areas. There is a recognition that working toward the same goal and common measures is essential for change. As described in Hanleybrown (2012), achieving large-scale impact requires defining a common agenda, increasing cross-sector alignment and learning among organizations, coordinating actions, establishing common measurements, and sharing lessons learned.

In its efforts toward collective impact, CAHSI INCLUDES is establishing three regional pilots:

Southwest region that includes DACC, El Paso Community College (EPCC), NMSU, NMSU-A, UTEP, and local government entities; Southern California region that includes CSU-DH, West Los Angeles College, and the Southern California Consortium of HSIs; and Northern California region that includes CSU-Fresno, CSU-Stan, San Francisco State University (SFSU), MC, and UC Merced. Across all three regional efforts, a common effort has been established with (a) Mentor Net to connect students virtually with professionals and expand and strengthen their professional networks and (b) Google to provide professional development and recruitment into the field. The pilots are building on CAHSI's proven organizational processes while investigating solutions to issues associated with scale and extended reach.

The three phases of the regional pilots follow the FSG broader impact model (Hanleybrown et al., 2012): planning for impact, initiating action, and sustaining actions and impact. CAHSI INCLUDES is currently in the planning phase. One of the early efforts has been on identifying current programs at the participating colleges and universities, non-profits, and industry. From the responses, we have organized the efforts into the primary categories shown at the top of Fig. 1. We now are in the process of identifying relationships among various initiatives and areas of potential alignment with stakeholder input. The launch pilot meeting for each pilot has been focused on: 1) learning about the NSF INCLUDES program and regional pilot, 2) building relationships that shape the collective impact efforts, and 3) identifying additional champions.

As we move toward a plan of action and mutually reinforcing activities, we are asking participants to consider the following questions:

- *Alignment across educational pathways*: What evidence-based practices can be disseminated or adopted to improve the current state? What alignment is needed for students to move across different programs in the alliance?
- *Bridging across institutions*: What structures (memoranda of understanding, communication, or policies) are needed to improve bridging efforts? What evidence-based practices improve student success?
- *Recruitment*: What evidence-based practices can be disseminated or adopted to excite students about careers in computation-based STEM fields at each of the educational junctures?
- *Retention*: What evidence-based practices can be disseminated or adopted to increase student retention in computation-based STEM fields?
- *Career Preparation and Professional Development*: What evidence-based practices are in place to support student identity as a computational scientists or engineer and to enrich their experiences? What efforts can be aligned around internships?
- *Support Structures (learning, mentoring, and financial aid)*: What evidence-based practices focused student learning and mentoring can be disseminated or adopted?

Overarching questions that should be asked are: What partnerships can be leveraged to be more effective? What novel, innovative, or promising practices can be introduced and studied to address any shortcomings?

3. EXAMPLE PRACTICES

This section presents two of CAHSI's practices that have been disseminated across computing programs within the CAHSI alliance. It also describes UTEP's data-driven model for supporting the university's student success initiatives.

3.1 CAHSI Effective Practices

CAHSI departments embody the HSI mission to support all students towards success and, with that goal, support systems have been established within departments to bolster student retention (Gates et al., 2015). Two exemplar practices are the Peer-Led-Team Learning (PLTL) and the Affinity Research Group (ARG) models.

3.1.1 Peer-Led Team Learning

PLTL, a proven practice for retention in multiple disciplines (Department of Education, 2016), provides an active learning experience for students and creates leadership roles for undergraduates. CAHSI's PLTL initiative targets the first three CS course sequence (Alo et al., 2007; Roach & Villa, 2008). Peer leaders are selected from students who have successfully completed the course recently and undergo coaching on how to work with groups of students using cooperative learning techniques. Peer leaders meet with students weekly outside of class time to solve problems that align with the lab assignments and/or content that was taught over the past week. The PLTL model engages teams of students through hands-on activities guided by a peer leader. CAHSI's efforts

have extended PLTL to two-year feeder colleges with the intent to increase the computing pipeline to 4-year colleges (Gates et al., 2015).

CSU-DH and UHD leaders have been actively involved with the Peer-Led Team Learning International Society (2015). In addition, UHD has innovated PLTL with online, synchronous PLTL sessions that support non-traditional students. Peer leaders guide peer-led activities through voice and screen visualizations and interact with students via voice, chat, or text messaging. This new approach requires a lot of questioning on behalf of the peer leaders and asking students to reconcile differences in responses. UHD peer leaders have become adept at ensuring that the online format remains student centered and continues to support students' success.

PLTL has significantly contributed to students' persistence in their chosen major. Prior to the implementation of PLTL in "gate-keeper" courses, merely 77% of the enrolled students finished the course, while 87% of students completed the course after PLTL implementation. This ten percent increase in course completion rates is statistically significant. Likewise, Hispanic students showed a six percent increase in course completion, also statistically significant (Thiry & Hug, 2012).

3.1.2 Affinity Research Group Model

The ARG model emphasizes the deliberate and intentional development of technical, professional, and team skills, as well as the knowledge required for research and cooperative work (Gates et al, 2008; Villa et al., 2013). ARG is structured to broaden student participation by giving students opportunities to learn, use, and integrate these skills and knowledge. To date, faculty at 25 higher education institutions in 11 states and provinces within the United States, Puerto Rico and Canada have adopted the ARG model. These adopters represent 10 academic disciplines from engineering, science, liberal arts, and nursing colleges. In all, adopters involved 678 students in ARG activities in a single academic year, 2013-14. From 2009-2014, ARG students at CAHSI institutions have attended professional conferences more than three times the rate of a large, diverse national sample of students in Research Experiences for Undergraduates (REU) programs (2016) (63% for ARG students versus 18% for a national sample of REU students), and presented a paper or poster at a national conference at three times the national rate (45% for ARG students versus 14% for a national sample). Note that these differences are statistically significant (Thiry & Hug, 2012). Additionally, in the past academic year, 2014-15, CAHSI served 850 students in courses at its own institutions using ARG modules—over 2/3 of these students were Hispanic (Thiry & Hug, 2015).

3.2 Proposed Shifts in Thinking

Through Lumina Foundation funding in 2005, UTEP built the analytics infrastructure and undertook research to better understand factors that explain student success (i.e., retention and timely graduation) at UTEP. These student success studies provided valuable insights regarding predictors of student success and identification of students at risk (indicators such as work hours above 20 hours per week, high school preparation, and first-semester performance). Interventions based on the study led to dramatic increases in outcomes; degrees awarded increased by nearly 85% between 2004 and 2014, while enrollment only grew by 30% during the same period. In addition, focused interventions, such as senior-student advisement, led to a reduction in time-to-degree. A second Lumina study, which focused on replication with EPCC and two other minority-serving institutions, yielded similar results.

In 2015, UTEP's student success models moved from "risk" groups to explaining and predicting success of each *individual* student. This new approach focuses on understanding each student's situation and providing the right conditions for her or his success. This student-based analysis has changed UTEP's understanding of how to work and manage individual student success. One of the insights that emerged is that outcomes must extend beyond traditional measures, such as retention and graduation, and include more holistic outcomes-- the recognition that more can be done to ensure that each student has equal access to opportunities and success. UTEP's current student success initiative develops each student's talents and strengths using a variety of high-impact experiences. Ranging from undergraduate research and civic engagement to study abroad and student employment, these experiences increase confidence, enhance personal and professional skills, and equip students with a competitive advantage when they graduate and enter the workforce or pursue a graduate degree.

4. SUMMARY

A partnership of institutions and organizations from public and private sectors, all with an established record of advancing Hispanics in higher education,

provides a holistic approach to broadening participation that draws strength from each of its key partners to impact states with a large percentage of Hispanics. The partnership builds on the successful NSF-funded Computing Alliance of Hispanic-Serving Institutions (CAHSI) that has emerged as a significant pipeline of new recruits into computing graduate studies and the professoriate throughout this nation.

The broadening participation effort will establish a common agenda among the networked community that guides the vision and strategy for collective impact, conduct data collection to longitudinally track student movement across campuses, and launch regional pilots to test feasibility of the full-scale plan and process for change. While some prior research identifies strategies for increasing graduate program completion rates for underrepresented minorities, little attention has been paid to the role of HSIs in reducing attrition. Attention to HSIs is a critical element in developing successful pathways to STEM careers. The networked community will involve social scientists across the different regions in research on Hispanic graduate program completion.

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Thriving Black and Latinx Technologists

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ABSTRACT

Code2040 is helping Black and Latinx undergraduate- and graduate-level technologists thrive in the innovation economy in which they have been historically underrepresented. Battling through Imposter Syndrome and lack of confidence, these students are persisting in the sector and in the Computer Science major at their respective universities, in part, because of the networks they create in Code2040's Fellows Program and Tech Trek via our cohort model.

1. INTRODUCTION

Code2040 is a nonprofit organization that creates pathways to educational, professional, and entrepreneurial success in technology for underrepresented minorities with a specific focus on Black and Latinx people. Code2040 aims to close the achievement, skills, and wealth gaps in the United States. Our goal is to ensure that by the year 2040 - the start of the decade when the U.S. will be majority people of color - we are proportionally represented in America's innovation economy as technologists, investors, thought leaders, and entrepreneurs.

Our programming is focused on supporting emerging tech talent. Our flagship program, the Code2040 Fellows Program, is targeted at college- and graduate-level students with excellent technical skills who are excited by the opportunity to spend a summer working with the best in the industry in San Francisco and Silicon Valley. Our newest student-focused program, the Technical Applicant Prep Program (TAP), is for students and young professionals looking to learn what they need to do to land top internships and full-time jobs in tech companies and departments around the country.

Code2040 is also working with emerging entrepreneurs through our Code2040 Residency Program, powered by Google for Entrepreneurs. Through both our existing programs and custom engagements, we work with tech companies from startups to industry leaders to craft unique, impactful partnerships and initiatives that will help them attract, hire, and retain diverse talent.

Recently, Code2040 has expanded its workforce development focus to include programming and data collection on the retention of Black and Latinx students majoring in Computer Science. Early data shows that the Code2040 cohort model impacts the major factors contributing to lack of persistence in the undergrad major. However, some of our findings within the Fellows Program show that once students have exposure to the tech industry they change their graduate school plans. Some of the information shared within this paper is part of our soon-to-be published comprehensive survey of our 2016 Fellows cohort.

2. IMPOSTER SYNDROME

Code2040 Fellows often entered the summer program suffering from some degree of imposter syndrome – a cognitive distortion that prevents people from internalizing any sense of accomplishment (Gravois 2007). In lay terms, it is a feeling of intellectual phoniness where individuals fear they will be found out as unworthy of the success they have attained (Katz 1986) and is frequently experienced by people of color, women, and/or high achievers (Clance et al. 2008; Ewing et al., 1996). Intense feelings of imposter syndrome can interfere with the academic and career achievement of high-achieving people of color by prompting them to disengage from their academic and/or occupational endeavors; avoid situations in which they will be evaluated; undergo persistent feelings of inadequacy; and feel an unhealthy pressure to succeed (Ross et al. 2001; Peteet, Montgomery and Weekes; Chrisman et al. 1995; Clance et al. 2008). As one fellow explained,

> I grew up in a predominantly white neighborhood. I went to one of the best elementary schools in [the city] and later one of the best high schools. My Mom always made sure we lived in good neighborhoods, and that I was a presentable young man. With that being said, I've always been confident in my abilities and have always believed I could achieve whatever I wanted as long as I put my all into it. I still believe that today. I think it's interesting that with my upbringing, and always being told I can achieve anything I put my mind to, Imposter Syndrome was something I had to overcome 110%.

The average imposter syndrome score decreased 22% between the start and end of the summer program, indicating fellows' feelings of being an imposter lessened considerably due to programming components. This was not the case for all students, however. Non-visible people of color experienced only ~1% drop in their composite score while visible people of color underwent a drastic 34% drop in score. Although both groups started with similar average imposter syndrome scores, those taken following the conclusion of the program were 30% lower for visible people of color than for their non-visible counterparts.

The important distinction between visible and non-visible people of color cannot be overstated. Some of the work we're doing at Code2040 will involve reimagining our curriculum to ensure that all of our program participants feel empowered and confident in their skills and that they have a feeling of belonging in the innovation economy.

3. COHORT MODEL

Code2040's Fellows Program and Tech Trek rely on the cohort model in order to build and foster community among Black and Latinx technologists whom often feel ostracized or "othered" in school and in the workplace. The cohort model gives students a chance to be in the same room with other Black and Latinx technologists from across the country while being able to talk freely and safely about their personal and professional struggles and triumphs.

3.1 Tech Trek

In 2016 Code2040's TAP Program launched Tech Trek; an exclusive weeklong convening for students and companies that will takes place in Silicon Valley. Tech Trek provides a platform for students to engage with company leaders, engineers, investors, and innovators from diverse backgrounds to acquire the knowledge and leadership skills necessary to be successful in tech. The impact that Tech Trek had on students is evident by this participant's story,

> Tech Trek opened my eyes to something that I previously thought to have been out of my reach -- the tech field. A few weeks before applying to Tech Trek, I hit what I now consider to be one of the lowest points in my career. I had interviewed on-site for an internship position at Microsoft, and soon received the news that they did not want to move forward with my application. At the same time, I had failed a midterm for two of my required classes (Calculus and Physics). At that point, I was failing most of my classes, and had received a rejection from a dream internship. It was at that moment when I began to doubt myself and strongly considered to switch my major to something "easier." Soon after I found out about Code2040 and I decided to apply to Tech Trek. I was lucky to be one of the 40 members to be selected to participate in the one-week program/boot camp. It was one of the best experiences that I have ever had. I soon learned that I suffered from something called "Imposter syndrome" and that I was not alone. I was able to identify myself with others that were like me, and realized that the imposter syndrome was something that is unfortunately common in our community as minorities/people of color. During that week, I made amazing friendships that will hopefully last for a lifetime. I still keep in contact with many of the other participants and I can clearly feel the sense of family and companionship that Code2040's Tech Trek created. Fast-forward one year since Tech Trek, I consider myself a completely different person. I have reached new heights that I could have never imagined myself achieving. I was able to obtain a position at Intel for the summer of 2017 as a Software Engineering intern and as a 2017 Code2040 Fellow. I also began entrepreneurship and recently won second place in a competition at "UCSB Startup Weekend." I was also able to publish my first academic paper at a national conference -- all within the span of a year after Tech Trek.

> Tech Trek marked the turning point of my career and gave me all the necessary motivation to continue. It also inspired me to help others that are in the same position as I was. I now hold different leadership positions in pro-diversity clubs, and take it upon myself to reach out to those who seem to be going through a similar phase as I was a year ago.

The experience of this student is mirrored in the research done on our broader student population.

3.2 Fellows Program

Code2040 summer program participants exhibited marked improvement in several aspects of their self-perception over the course of the fellowship. These shifts are particularly dramatic given the short period over which they occurred.

- Fellow's average internal locus of control increased 11%.
- Code2040 fellows' general self-confidence scores grew by an average of 10%. There were substantial disparities in both the pre- and post-program scores of visible vs. non-visible people of color as well as women vs. men.
- Work-related self-efficacy scores increased significantly as did the number of business-related skills in which students felt at least "somewhat confident".
- Internships provided fellows with excellent exposure, resulting in them gaining hands on experience with an average of 1 new language or technical approach and 3 new software engineering processes.
- Fellows significantly expanded their career-related networks as a result of Code2040. The median number of fellows' LinkedIn contacts increased 45% over the summer.
- Overall, over one-third of fellows changed their graduate school plans between the pre-Code2040 and post-Code2040 surveys. Of note were the 31% of fellows that initially responded affirmatively about their plans to attend grad school, but changed their minds.
- Code2040 fellows increased their familiarity with and interest in a larger number of computer science related jobs over the course of the fellowship.
- The average number of jobs fellows were at least somewhat familiar with rose from 9.7 to 14.3 (out of 17).
- The average number of jobs in which fellows expressed interest rose from 2.0 to 6.7 (out of 17).
- Fellows were extremely satisfied with their overall experience with the fellowship program. Code2040 fellows were particularly impressed by the sense of family and networks they'd built up over the summer. A number of students commented on the self-confidence and motivation they gained through the program, while others lauded the skills and work experience Code2040 had provided. Still other fellows saw tremendous value in learning to deal with the tech sector as a person of color. In the end, almost 90% rated the program "excellent" and their average likelihood of recommending it to a friend or colleague was 9.8 out of 10.

Creating a community of Black and Latinx technologists through our cohort model provides an opportunity for them to join their peers outside of the office and create a family-like environment and expand their networks. This space allows them to gain confidence in their abilities and realize that they are not alone which happens both at school and the workplace.

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The Importance of a Diverse Faculty for Broadening the Undergraduate STEM Pipeline

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ABSTRACT

There is much discussion these days on increasing the number of students in the undergraduate STEM pipeline and in particular among traditionally underrepresented students. At the same time, students at many universities are demanding that the faculty composition be more representative of the changing demographics. The response from university administrators is hopeful, yet we also know that it will be challenging to meet those demands. The current process for hiring faculty can be cumbersome, archaic, and not likely to yield desired results. If this is the case, can we do anything about improving the hiring process? Here, I propose several possible strategies that could be used to improve the overall hiring process and discuss the advantages of having a more diverse faculty body on our campuses.

1. INTRODUCTION

There is much discussion these days on the importance of broadening participation in STEM undergraduate programs and particularly among traditionally underrepresented minorities and women. The world is certainly changing rapidly and the student demographics are reflecting the changes nationally. At UC Merced, 71% of the undergraduate students are first-generation and 51% are Hispanic. Across the country we are seeing similar trends, with increasing numbers of traditionally underrepresented minorities. The same cannot be said of the faculty numbers.

Students at many universities are aware of these trends and are demanding that the faculty composition be more representative of these changes. The students are rightfully concerned with the current situation. It is not the case that faculty from different backgrounds as their own can't be good mentors, advisors, and teachers. In fact, it is crucial that all faculty play an important role in promoting diversity within their campuses.

But faculty from underrepresented minority groups play an especially important role in retention. For many students from these groups, URM faculty represent what I call "existence proofs". To these students, seeing a faculty member from their own group at a university means that in fact they belong at these institutions of higher education and perhaps that one day they might also achieve that status. This sense of belonging is crucial to many underrepresented minorities and first-generation students who in many cases are already unsure as to whether higher education is the right career path for them.

Minority and female faculty also play an important role in listening to issues that these students are unlikely to bring up to other faculty that they may not identify with. Here a level of trust is almost always a part of the issue. Whether rightfully or not, students usually make an implicit assumption that someone from a similar background understands the issues that they are facing. They thus feel safer in bringing up sensitive topics related to academic issues and doing so at earlier stages. And early intervention often leads to better retention rates.

For this and other reasons, it is important for the academy to seriously consider and address the demographics of our faculty body so that it better reflects the diversity of the student body. In my experience, the importance of role models for women and underrepresented minorities cannot be overemphasized.

The response from university administrators is hopeful, yet we also know that it will be challenging

to meet those demands. In a recent survey, chief academic officers (CAOs) generally believe their institution values racial and ethnic diversity in faculty hiring. In particular, 53% of CAOs strongly agree or agree that most academic departments at their institution place a high value on diversity in the hiring process. Interesting, "62% strongly agree or agree that their college will need to make hiring decisions in new ways to bring about a more diverse faculty."

However, there is also concern whether targets for minority hiring in higher education are realistic and whether they their own colleges can reach their targets.

There are several reasons for this. For one, we know that this is a long-term problem and it will take time to change the diversity in our faculty body. The recruiting process is slow and decisions involve many people all with a strong interest in what is rightly viewed as important decisions with 20-30 year consequences and having major impacts on teaching and research directions within the university. Secondly, the budgets at many universities have been steadily declining so administrators are faced with hard decisions for allocating resources and funds for new faculty FTEs can be difficult to come by. However, this is the reason that each and every faculty hire has to be considered carefully. In my experience, if you can't make an enthusiastic offer, it is better to wait another year.

But there are deeper issues that make diversifying the faculty body even more difficult and that is the recruitment and hiring process itself. The process of how we presently hire faculty can be cumbersome, archaic, and not likely to yield desired results.

2. IMPROVING THE HIRING PROCESS

I would propose that hiring processes in general are far too restrictive leading to narrowly defined pools with candidates that look all too similar. In addition, there is little to no training of most of the people involved in the hiring process, with the inherent issues that arise from this lack of training. Finally, it is unclear to me whether today's processes actually yield better faculty in the end as success can only be defined after rather long lag times.

If this is the case, can we do anything about improving the hiring process? First of all, I think that we need to have a national discussion on how we can do better. Because this is an issue that cuts across many constituencies, all interested parties should have a say in this including: students, faculty, and administrators. If possible, it would be good to gather some data on how effective we have been in recruiting, hiring, and retaining faculty.

To be more specific about improving the process itself, I have 4 specific suggestions: 1) when writing the job posting schools should use the broadest possible description that makes sense; 2) the departments should define and agree on the criteria for the position ahead of time; 3) schools should require a diversity statement from all applicants; 4) schools should consider using the "Rooney" rule, 5) the search process should be viewed as a multi-year process.

3. PROPOSED STRATEGIES

3.1 Job Posting

Taking each point in turn let me first discuss the job posting. In my experience, there are many cases where a job posting has been tailored so as to essentially narrow down the pool to a few candidates (and sometimes to just one). If the overall goal is to attract the best faculty to a university, this tactic would seem to be counterproductive. Yet it persists, because it is human nature to believe that we know what talent looks like and that we can predict future success for our colleagues based on our own experiences (see Kahneman). Broadening the job posting also invites more applicants, which many search committees are reluctant to even think about, because of the extra work. However, if the goal is to produce the best candidate and thereby enhance the scholarly reputation of the university does it not make sense to attract as many candidates as possible?

3.2 Selection Criteria

With regard to the criteria for selection there are two phases of the search where this is critical. The first is selecting candidates from the overall pool to generate the "short-list". The second phase is in the final ranking of the candidates who were invited to the campus visit. In both cases it is critical that all involved are agreed on what criteria are being used to evaluate the candidates. In one case I'm aware of, a couple of search committee members decided on their short list based on whether applicants had an existing grant or not. I asked them for a clarification on how that criterion was chosen and whether it had been one of the job requirements. Of course the answer was no,

it was not listed as a job requirement, but it was supposedly indicative of future success. The point being however that ill-defined criteria or criteria that not everybody has agreed to, will likely yield inconsistent or unanticipated results.

This also highlights the importance of training for search committees. As we now know of course, there is implicit (unconscious) bias in all of us. And we know that even just acknowledging that bias will help us make better decisions. This and other cognitive biases have been in the news recently with the books by Danny Kahneman (Thinking Fast and Slow) and Michael Lewis (The Undoing Project), both of which can provide us with greater insights on how to make better decisions. Furthermore, it is easy to be swayed that the best judges of faculty candidates will be other faculty in similar fields. As Kahneman's work has shown, there is an innate "overconfidence effect" that leads us to overestimate our knowledge in many situations and to a large extent it is more common in experts than in lay people. Should we incorporate some of these ideas into revamping our hiring process?

3.3 Diversity Statements

The third point has to do with diversity statements. For many years, the norm has been to ask the candidates to provide a research and a teaching statement. Several years ago, we instituted a requirement that a diversity statement also be included in the application package. In my experience, this has been one of the more successful strategies leading us to hire 18 women faculty, and 6 URM faculty out of 34 overall in the School of Natural Sciences. In my opinion, the diversity statement has been useful for three main reasons. The first is that the requirement makes a strong statement to candidates that diversity is important to the institution. In fact, many candidates I have interviewed have told me that they applied to UC Merced specifically because they saw that a diversity statement was required. The second reason is that it reminds everybody inside the university, and the search committees in particular, of the core values the institution holds and that diversity should be one of the criteria by which to rank the candidates. Finally, and I think importantly, it allows for a natural conversation on diversity during the interview process. In my experience asking candidates about their diversity statements, I have come to a deeper and more meaningful appreciation of the diversity in our candidates.

3.4 The Rooney Rule

The fourth point is consideration of the "Rooney Rule". If you're not familiar with the rule, it is named after Dan Rooney, who was the owner of the Pittsburgh Steelers and the chairman of the NFL's diversity committee. In short, it is an NFL policy that requires league teams to interview at least one minority candidate for head coaching and senior football operation jobs. My predecessor at UC Merced had a policy where search committees were allowed to bring in 3 candidates for a campus visit. In addition, they could also bring in a fourth candidate if they had a diverse visit list–I kept that policy in place. I should point out that the fourth candidate is not a requirement, but more of an incentive to see more candidates, so it's not a strict interpretation of the Rooney rule. And in fact, several search committees have chosen to not take advantage of the extra slot. Is the rule good, bad, inconclusive? I think the jury is still out on this. The advantage is that in many cases, it does diversify the pool. The disadvantage is that too many times, the fourth candidate is viewed as strictly the "diversity candidate". Overall, however, the data seem to indicate that this tactic does provide for a more diversified short list, and often the committee is “surprised” by the candidate who may not have looked as strong on paper. I believe this has led to more offers to URM and female candidates.

3.5 Multi-year Hiring Process

The final point is that universities should regard the entire hiring process as a multi-year process. In some cases, departments worry that a failed search will lead to the FTE being taken away. In other cases, search committees do not want to endure another search process. On the other end of the recruiting process, many departments don't start to look for candidates until an FTE is secured, which means the process will secure the best candidate at that particular point in time, and neglect someone that might be on the job market one year in the future. A better strategy would be to keep an eye out on talented candidates 2-3 years in advance of possible FTE allocations–a process that would require joint faculty-administration coordination.

4. CANDIDATE PREPARATION

Finally, let's consider the hiring process from the perspective of potential faculty candidates. I suggest that the academy should also do more to prepare graduate students for interviewing. Of course there are great examples of departments and advisors who mentor their students on how to prepare for interviews, but these practices need to be more widespread. I've seen far too many URM students go out on the job market; students that I know are smart, motivated, and resourceful. I've also seen many of these same students who end up without job offers because they were ill prepared for their interviews. This is what I call not knowing the unwritten rules of interviewing.

It goes without saying that even a little preparation will go a long way, but since many URM students also come from first-generation families or from smaller schools, many of them don't know the expectations of an interview, especially at large or research-intensive universities.

In essence they are trying to make up for 20+ years of preparation that other students have had because of their upbringing. Dr. Luo-Luo Hong, Vice President of Student Affairs and Enrollment Management at San Francisco State University, likens this to having 2 computers except one of them comes pre-loaded with all your favorite software. The computers will both do the job, but the one without the software will take more preparation before it's ready to use. Once again, this is a place where URM faculty need to play a special role, but all faculty should contribute.

5. SUMMARY

The need to broaden the undergraduate STEM pipeline is one of critical national importance. To recruit and retain underrepresented minorities and women in these fields, one of the best strategies available is to have a diverse faculty body. Reaching these goals will be a difficult but not insurmountable challenge. Our current hiring practices however are not well suited to diversifying the faculty and we need to have a national discussion on how to improve them. Finally, URM faculty (and administrators) have a special role to play from both a perspective of serving as role models for our student and promoting diversity, but ultimately everybody must contribute–it is after all a shared responsibility in our future.

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The Importance of Community, Belonging and Support: Lessons Learned from a Decade of Research on Hispanic Retention in STEM

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1. INTRODUCTION

Hispanics are the fastest growing minority population in the US, yet Hispanic undergraduate degree attainment, particularly in STEM fields, lags behind that of majority students (NSB, 2016). Hispanics comprise nearly 18% of the U.S. population and 23% of the adolescent population, but were awarded only 11% of STEM bachelor's degrees in 2013 (US Census, 2015; NSB, 2016). Still, the overall number of STEM baccalaureate degrees awarded to Hispanics has increased by 57% from 2000. Most notably, the number of Computer Science bachelor's degrees awarded to Hispanics has increased by 75% since 2000. Thus, the proportion of STEM bachelor's degrees awarded to Hispanics is increasing, but not fast enough to address the stubborn disparity between Hispanics and majority students.

Recent research has identified a number of social, cultural, economic, and educational factors that underlie the inequities in degree attainment between Hispanic and majority students (Hurtado, Carter, & Spuler, 1996; Oseguera, Locks, & Vega, 2009). Prior to college entry, Hispanic students are less likely to have completed college preparatory mathematics and science coursework and more likely to attend K-12 schools that emphasize basic skills over higher-order thinking and college readiness (Tyson et al., 2007). Once Hispanic students arrive on campus, lack of faculty support and discomfort on the university campus contribute a lack of sense of belonging in higher education and, ultimately, lead to high undergraduate attrition rates (Gloria et al., 2005). Poor experiences in gateway courses contribute to a loss of interest for some underrepresented minority students and women (Crisp, Nora & Taggert, 2008; Hurtado et al., 2010; Johnson, 2007; 2011; Seymour & Hewitt, 1997). Hispanic undergraduates are also more likely to face financial obstacles in college (Santiago & Treindl, 2009). In STEM disciplines, in particular, cultural incongruence between minority communities and academic STEM departments contributes to the underrepresentation of some minority groups in these majors (Bonous-Hammarth, 2000; Cole & Espinoza, 2008).

Despite these barriers, researchers have explored factors that contribute to the persistence of underrepresented minority students in STEM. Effective mentoring in scientific and technical education can increase the retention of women and other underrepresented students (Margolis & Fisher, 2002). Academic factors within the institutional environment affect the retention of women and minorities more strongly than incoming academic characteristics; so active learning strategies, such as peer-led team learning or inquiry-based learning, can increase minority student retention and achievement (Freeman et al., 2014; Thiry et al., 2011). Co-curricular practices, such as undergraduate research or participation in STEM-related clubs, introduce students to the technical and collaborative nature of STEM disciplines, promote a sense of belonging, influence career aspirations, and increase graduation rates (Herrara & Hurtado, 2011; Chang, 2008; Clewell et al., 2006; Espinosa, 2011; Chang et al 2014; Hurtado et al., 2010; Jones, Barlow, & Villarejo, 2010). Identity and belonging in STEM are also important factors in the persistence of underrepresented minority students, especially for women of color (Carlone & Johonson, 2007; Tate & Linn, 2005). Thus, prior research on postsecondary STEM education has elucidated culturally-embedded reasons for the racial disparity in STEM fields and identified promising strategies for supporting students once they have enrolled in STEM majors.

In this paper, I will discuss results from two studies that provide insight into the obstacles faced by Hispanics in STEM fields and the ways that Hispanic students succeed in STEM majors. The first of these studies is a mixed-methods study drawing on student interviews and academic records data from six primarily-white colleges and universities of varying institutional types. In this

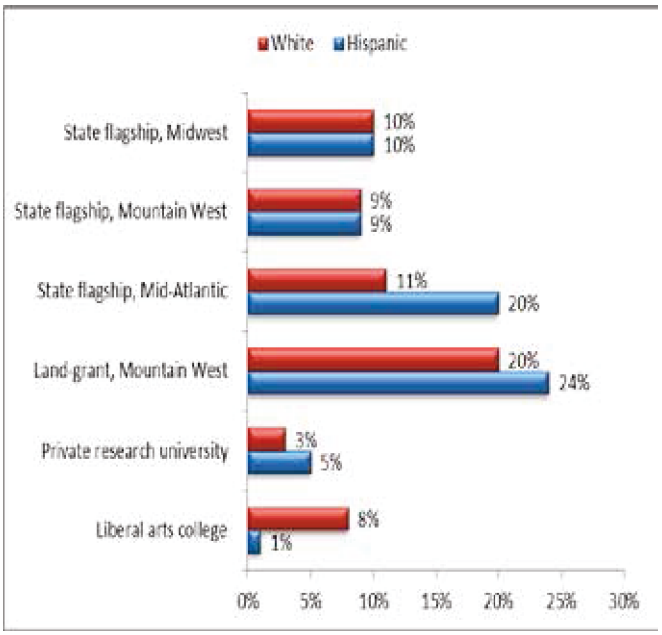
study, titled *Talking about Leaving Revisited*, we investigated the original institutions represented in the seminal *Talking about Leaving* study to see what has and has not changed in students' STEM learning experiences in the past 20 years. Then, I will discuss results from the external evaluation of the Computing Alliance of Hispanic-Serving Institutions (CAHSI), a consortium of computer science and computer engineering departments that has adopted the use of evidence-based teaching and learning strategies to increase the recruitment, retention, and advancement of Hispanic students. The evaluation of CAHSI includes student and faculty interviews, institutional records data, and student surveys. In this white paper, I first draw on findings from *Talking about Leaving Revisited* to describe some of the reasons that Hispanic students may leave STEM majors. Next, I discuss findings from the external evaluation of CAHSI to illustrate some of the practices that promote the retention of Hispanic students in STEM and computing. I compare these findings to research results from *Talking about Leaving Revisited*.

2. WHY DO HISPANICS LEAVE STEM FOR NON-STEM MAJORS?

In the *Talking about Leaving Revisited* study, my colleagues and I explored many aspects of students' experiences that contributed to their decisions to leave a STEM major for a non-STEM major. Many of these factors were more prominent for Hispanic students than for White students, yet Hispanic students were not significantly more likely to leave STEM majors for non-STEM fields when all campuses and disciplines are considered. Nevertheless, there were distinct disciplinary and institutional differences. For instance, Hispanics were more likely to switch out of engineering, biology/life sciences, and computer science than White students at the six institutions included in the study (e.g. 6% vs 3% attrition rate in computer science, respectively, and 28% vs 18% in biology/life sciences, respectively) yet this disparity was not present in mathematics or the physical sciences. Just as important as disciplinary differences, there were distinct institutional differences in switching rates, even for similar institutional types (see Figure 1).

As illustrated in Figure 1, there are differences in overall attrition rates from STEM to non-STEM majors across institutional types and within institutional types. Some institutions, such as the

Figure 1. Percentage of undergraduate student switchers from STEM to non-STEM majors at each institution



Midwestern and Mountain West state flagship schools had equivalent attrition rates across groups, while other institutions, such as the mid-Atlantic flagship had greater disparity. Clearly, institutional context matters not just for the retention of Hispanic students, but for the persistence of all students in STEM majors.

These differences were affirmed in the interviews that we conducted with 346 students at these six institutions. While these campuses were all primarily-white institutions, nearly 10% of interviewees were Hispanic and 16% were underrepresented minorities. Nearly 100 of the student interviewees had switched from a STEM to a non-STEM major, while the remainder had persisted in STEM, despite great obstacles for some. I will first focus on the most important factors that contributed to Hispanic students' decisions to leave a STEM major.

2.1. High School Experiences

Not surprisingly, students' access to high-quality high school curriculum and coursework was not equal across our sample of students. Hispanics were more likely to report that they did not have access to rigorous AP or IB coursework in high school and that their high schools did not adequately prepare them for the demands of college (see Figure 2), even for those students near the top of their high school class. A significant sub-set of students, especially Hispanic students reported that their high school

Table 1. Self-reported high school preparation of STEM non-switchers and switchers, Hispanic and White students, (n=346)

	Non-switchers		Switchers	
	White	Hisp.	White	Hisp.
Reported poor math preparation	17%	22%	24%	67%
Lack of access to AP/IB courses	9%	0%	13%	22%
HS preparation contributed to switching decision	n/a	n/a	13%	33%

preparation had contributed to their decision to leave STEM in college. On the other hand, White and Hispanic non-switchers had similar academic backgrounds.

2.2 Transition to College

Students' prior academic experiences and background affected their transition into college, particularly for Hispanic, other underrepresented minorities, and first-generation college students. In particular, students from under-resourced high schools struggled with the workload and amount of studying required in college STEM courses, the differences in testing practices between high school and college, the pace of college classes, and the large class size in many introductory classes. Hispanics were more likely to feel demoralized by these types of challenging experiences in their transition to college. Indeed, 33% of Hispanic switchers and 17% of White switchers felt lost and overwhelmed during their first year in college. Consequently, Hispanic students were more likely than White students to attribute part of their decision to switch out of a STEM major to these negative college transition experiences. Similarly, a significant portion of non-switchers were also affected by these same transition issues and yet persisted to complete their degree in STEM. Yet, while non-switchers also experienced challenges in their transition to college, they did not experience them in such a negative way as did switchers. For instance, only 6% of Hispanic non-switchers and 3% of White non-switchers reported the same sense of feeling lost and overwhelmed at the start of their college experience. Thus, switchers and non-switchers appear to face similar challenges in their transition to college, yet students who leave STEM majors are much more negatively affected and demoralized by these difficulties. This difference points to the fact that students need strong institutional and peer support from the moment they step foot on campus to begin their studies, if not before.

2.3 Gateway Courses and Belonging

While the factors contributing to students' decisions to leave STEM are multifaceted and complex, students' experiences in introductory, gateway courses and their perception of departmental and classroom climate significantly affected their sense of belonging in a STEM field which, in turn, impacted students' persistence. Switchers and non-switchers experienced introductory courses in very different ways. For example, non-switchers reported fewer negative experiences in gateway courses and little impact on their sense of belonging in STEM. On the other hand, switchers were more likely to report negative impacts from large class sizes, poor testing and grading practices, and competitive classroom or departmental climates, all of which contributed to a lack of belonging in STEM. A lack of belonging in STEM was often related to students' decisions to leave STEM to pursue a non-STEM major. Competitive atmosphere, lack of peer support, gendered or racial isolation, and large class sizes were some of the reasons that led to a lack of belonging for STEM switchers, especially for underrepresented minority students. For instance, 44% of Hispanic switchers and 23% of White switchers reported that a lack of belonging in their major influenced their decision to switch out of STEM. Thus, students' decisions to leave a STEM major were often influenced by negative experiences in introductory courses and a sense that they did not belong in the major.

2.3 Help-seeking and Institutional Resources

Issues with availability of institutional and departmental support and negative (or lack of) interactions with faculty and peers out of class also contributed to the decision to switch out of STEM for some students. Similar to other factors related to attrition, Hispanics were more negatively impacted by lack of support or difficulties in finding appropriate help. For instance, 22% of Hispanic switchers and only 7% of White switchers noted that

their difficulty in getting help contributed to their decision to leave STEM. Hispanic switchers were also more likely to report negative experiences in peer study groups (33% of Hispanic students, 17% of White students, and 67% of African-American students). On the other hand, there were no differences between Hispanic and White non-switchers in their experience of unsupportive or unhelpful faculty or their ability to access appropriate institutional resources.

3. WHAT SUPPORTS HISPANIC RETENTION IN STEM AND COMPUTING?

3.1 The Computing Alliance of Hispanic-Serving Institutions (CAHSI)

CAHSI is a consortium of computer science departments that has adopted and adapted evidence-based teaching and learning practices to improve Hispanic student success and degree completion. These initiatives support students throughout their undergraduate career and beyond. CAHSI also provides mentoring and professional development opportunities to students and faculty, and strives to incorporate an equity mindset into departmental practices.

3.2 Improving College Readiness

CAHSI institutions have increasingly been conducting outreach into K-12 schools, but member departments also take responsibility for the educational environment and support that they provide for entering students regardless of their academic background. For instance, many CAHSI departments offer a CS-0 course for students who have not had prior exposure to the academic and technical expertise needed in an introductory programming course. CS-0 courses enhance the preparedness of students so they have the skills and knowledge to succeed in later computer science courses. Evaluation results show that Hispanic students who took CS-0 completed the next course in the computer science sequence, CS1, at higher rates than Hispanic students who had not taken CS-0.

3.3 Increasing Success through Peer Support

To support students in introductory courses, CAHSI employs Peer-Led Team Learning (PLTL) to engage students in supplemental learning sessions guided by a peer leader. In these sessions, students participate in cooperative, active learning opportunities led by near-peers who have excelled in the course in past semesters. Peer-led team learning cultivates pedagogical leaders since peer leaders serve as role models for undergraduates and represent the "next steps" along the academic path.

CAHSI PLTL efforts have increased student retention in critical, gate-keeper courses in the computing major. Institutional data of course completion rates were compared to examine the effects of PLTL on retention rates in these gate-keeper courses. Our analyses examined if there were statistically significant rates of course completion for all students and for Hispanic students after the PLTL offering was introduced, and if the PLTL offering showed significant effects on completion rates when other variables, such as ethnicity or gender, were held constant using logistic regression models. Comparison of all students at CAHSI institutions demonstrates that students enrolled in gateway courses with PLTL passed at significantly higher rates than students enrolled in non-PLTL sections [X^2 (1, N=5195)=53.07, p<.01].

Logistic regression including all schools showed a positive effect for PLTL participation on course completion even when other variables were held constant. Logistic regression also showed significant effects for gender and Hispanic ethnicity, indicating that PLTL was particularly effective in retaining Hispanics and women.

Peer support was also critical for student retention in the *Talking about Leaving Revisited* study, especially for Hispanic students. In fact, 72% of Hispanic STEM students attributed their persistence, at least in part, to their support system both inside and outside of their department. Peers within the department, though, were the linchpin of Hispanic students' academic support system.

3.4 Enculturation into Disciplinary Communities

Another key CAHSI initiative, Affinity Research Groups (ARG) engage undergraduates in authentic research work within teams of faculty, undergraduate, and graduate students. ARGs emphasize the deliberate and intentional development of the technical, intellectual, communication and professional skills and knowledge required for research (Gates et al, 1999; Villa et al., 2013). In the Affinity Research Group model of undergraduate research, students are exposed to increasing levels of independence,

responsibility, and technical sophistication as they gain research experience. Within CAHSI departments, the ARG model has been implemented in apprentice-style, out-of-class research experiences and within STEM courses that use the ARG model to emphasize collaboration, teamwork, and professional development within capstone courses in the computer science major.

CAHSI ARG students publish in refereed journals at rates higher than a national sample of NSF Research Experiences for Undergraduates (REU) students: 17% of ARG students and 5% of the national sample authored papers. Differences in conference attendance and presentation between CAHSI ARG and national REU students are statistically significant as CAHSI ARG students attend conferences and present at higher rates than the sample of summer research students (X^2=27.864, =.000 and X^2=15.708, p=.001, respectively). In comparing ARG models, CAHSI students in out-of-class research experiences with a faculty mentor and a team of peers reported stronger gains in understanding the nature of research, research skills, professional preparation, and had higher graduate school aspirations than students who participated in an ARG course. Students in out-of-class research experiences and ARG courses made equivalent gains in collaboration and teamwork.

Surprisingly, few students reported that out-of-class, co-curricular experiences, such as undergraduate research or internships, contributed to their STEM persistence in the *Talking about Leaving Revisited* study. However, this finding is related to the lack of broad access to these opportunities at the research study institutions—one of the reasons that CAHSI has begun to implement the ARG model within required coursework. Nevertheless, 11% of Hispanic students and only 1% White students in the *Talking about Leaving Revisited* study noted that research experiences influenced their retention.

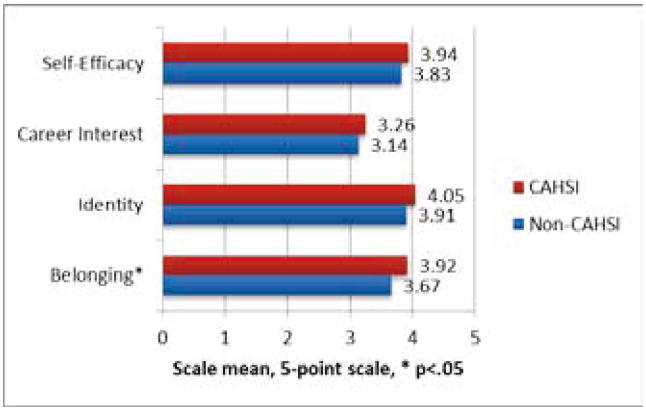
3.5 Institutional and Departmental Supports

While an inability to access necessary out-of-class academic or social support contributed to student movement out of STEM majors, perhaps not surprisingly, the opposite was true in promoting student retention in STEM in the *Talking about Leaving* Revisited study. All of the institutions within the study offered supplemental tutoring or study sessions or other sources of support. These structural supports were very important for those students who did take advantage of them, especially for Hispanic and other underrepresented minority students. For example, 67% of Hispanic students and 29% of White students noted that institutional supports were vital to their success and retention in the major. Yet, as indicated by the experiences of switchers, not all students take advantage of these critical resources when they are offered on an optional basis. In contrast to optional support, CAHSI has increased the success of its students by embedding academic and social supports within the fabric of required courses. Thus, all students have equal access to peer mentoring, tutoring, or enrichment activities because they are a mandatory aspect of courses that all students must take to advance in the major.

3.6 Climate and Belonging

A negative climate and lack of belonging can contribute to attrition in STEM, especially for underrepresented minority students. To address these issues, CAHSI provides financial, academic, and social support for students throughout their undergraduate studies and into graduate school and the workforce. In a national survey of undergraduate computer science students, CAHSI students expressed a significantly greater sense of belonging than Hispanic computer science students at other institutions (see Figure 2). CAHSI undergraduates were also more likely to have developed an identity as a computer scientist and to display a stronger sense of self-efficacy in computer science than Hispanic students in non-CAHSI departments.

Figure 2. Identity and Belonging in CS, CAHSI and CRA National Sample, Hispanic Students Only (n=414)



Likewise, a sense of belonging and a positive departmental and classroom climate were critical factors in the retention of Hispanic students, and in fact, of all students, in the *Talking about Leaving Revisited* study. Indeed, 56% of Hispanic students

and 32% of White students expressed that their sense of belonging in the major and their commitment to their major or future career were influential to their persistence in their major. This sense of belonging was often cultivated through peer support, a positive departmental and classroom climate, and approachable faculty. Creating a system of support within and outside the classroom counters the deficit thinking approach that is often associated with Hispanic students in postsecondary education and replaces it with a student-centered approach that focuses on growth, development, and belonging.

4. CONCLUSION

Results from a decade of research within Hispanic-Serving Institutions and primarily-white institutions highlight the importance of a sense of community, belonging, and peer and institutional support for the success of all students, and particularly for Hispanic students. Most notably, community and belonging must be promoted with an equity mindset that all students can and will succeed with the appropriate support. The systematic and integrated adoption of evidence-based, student-centered practices within institutions and departments appears to be the most promising way to increase the retention of Hispanic students in STEM.

5. ACKNOWLEDGEMENTS

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NOTES

DISCUSSION: K-12, 2-YEAR INSTITUTIONS,

AND UNDERGRADUATE DEGREES

GRADUATE DEGREES: FROM RECRUITMENT TO COMPLETION FOR LATINOS IN STEM

Moderator: Antonia Franco, Society for Advancement of Chicanos & Native Americans in Science
Panelists: Pauline Mosley, Pace University
Suzanne Ortega, Council of Graduate Schools
Marjorie Zatz, University of California, Merced

Research on Latinas/os in STEM based graduate programs has revealed that although Latinas/os are pursuing higher education in record numbers, they are still one of the most underrepresented groups in STEM graduate programs. Research findings demonstrate that members of underrepresented groups who enter STEM graduate programs feel marginalized, often being the only person of their racial/ethnic background in a program. If they are first generation students, they may have little knowledge about graduate school, making the transition more difficult. Undocumented students may face additional barriers if they do not have work authorization, if they must take on family responsibilities because a parent is deported, or if they do not feel they can confide in their advisor.

Research on underrepresented minority STEM graduate students demonstrates the importance of multiple mentors, including peers, summer bridge programs, and solid financial support, among other factors, but implementation of such best practices has not been systematic. Researchers have called for more studies that consider the heterogeneity within URM populations and across different STEM programs to better understand how Latina/o and other underrepresented graduate students have successfully navigated STEM programs, as well as how institutions can better support them.

This panel will address both research needs and strategies for implementing known or hypothesized best practices to increase retention and completion rates for Hispanic and other URM graduate students in STEM fields.

The Ph.D. Support Network

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ABSTRACT

Hispanics continue to be underrepresented in the STEM disciplines within the Academy even though by 2050 they will comprise a third of the U.S. population. Hispanic faculty, unfortunately, have become victims to lack of effective mentoring, systematically racist institutional climates, and feelings of isolation which cause them to leave or seek a productive and conducive work environment. These deficiencies coupled with poor support infrastructures puts Ph.D. Hispanic students at great risk for incompletion. This paper presents the Ph.D. Support Network – a taxonomy for combatting these issues.

Keywords

Academy, Hispanics, Latinos, Ph.D., Ph.D. Support Network

1. INTRODUCTION

According to the Doctorate Recipient U.S. University Report 2014, the number of Hispanic students earning doctoral degrees has increased from 3.3% to 6.5%. (NSF 2014, Report). However, there are only 2% Hispanic full-time professors teaching out of the 1.5 million faculty degree-granting institutions. Hence, there is a strong disconnect in the STEM pipeline from acquiring a Ph.D. to securing a faculty position within the Academy. One of the biggest challenges confronting women and minorities is earning a doctorate. Most universities and colleges will allow faculty to teach without a degree; however, ascent within the academy cannot begin until one has obtained a Ph.D. Consequently, acquiring a doctorate is a monumental achievement for most women because of the time and cost required. One main reason women or minorities failed to complete the doctorate and remain ABD (All But Dissertation) is the lack of a mentor and poor support networks. "Studies show that 50% of both men and women, who begin a doctorate drop out at the dissertation-writing stage."

The dissertation process is a maze. One must understand curriculum, knowledge producing processes and procedures, as well as institution's culture, values, and power relations within and beyond the academy. These are critical success factors. Many potential Ph.D. candidates (abandon the path to advanced degrees) because they are lacking mentorship needed for successful navigation thru the dissertation maze. Others give up because they do not know how cope with the mechanisms of inclusion and exclusion driven by power relations in the academy. Students are inhibited by the challenges faced while writing a dissertation without meaningful support of a mentor and eventually withdraw from the process.

Lastly, another big issue with these most Ph.D. programs, especially for working women and women with children – is balancing studies with families. How do you support yourself or your children while attending school full-time and when you are not allowed to work? Most of the students enrolled in Ph.D. programs are international students who are on visas or being funded by their countries to get an "American Ph.D." with the intent of returning back to their countries, thus funding is not an issue for them. However, for Hispanic students this is a major issue. Stipends and student housing options are fine for the single student without a house or car notes, but, for the student who is married or has bills to pay this is rather daunting.

2. PH.D. SUPPORT NETWORK

What is a support network? A Support Network (PSN) is a pictorial diagram which shows people, groups, and organizations and their connections to you and what they can do to support you in achieving your goals. The nodes in the network are the people and groups while the links show the type of

relationship. The link is designated by a solid line and represents the frequency in which the interaction between the nodes. An effective SN will have all solid lines as oppose to broken ones (-----) signifying weak connectivity.

In figure 1, the mentor and family nodes are yellow. These two entities: family and mentor are selected by you. Therefore, it is imperative that you make wise choices. The other three entities: study groups, financial, and time management are fixed and the student will have to learn how to manage these nodes to the



Figure 1 – Ph.D. Support Network

best of their ability. Lastly, in the center of this network is the person who desires a Ph.D. – the student. Blending all of these components requires skill, tenacity, and understanding the learning curve associated with learning what works for you. The yellow-nodes are **giving-connections –** that is they provide something for the student; the student is NOT expected to give anything but to accept the support in whatever way it comes.

Success in achieving a PhD not only depends upon a close and effective working relationship with one's advisor and mentor, but it also hinges on the support network. In figure 1, it clearly shows the major entities needed in order to support a Ph.D. student. *Networking –* is the relationship building among people and entities with similar interests and goals. It is not a one-time event nor is it a one-sided approach where you never give anything back. Rather, it is a strategy that you can utilize to manage your career process. The ability to balance the nodes in the network is directly related to one's success. Study groups, family, mentorship, financial planning, and time management are the key components that each student must address and determine how they will work seamlessly in achieving the Ph.D. Cultivating the skill sets to selecting a "good" mentor is a process that one learns during this time, only to be repeated later on for tenure and advancement.

2.1 Self-efficacy - Mental Support

According to protection motivation theory, **self-efficacy** is the belief in an individual's ability to execute the recommended courses of action successfully (Rogers 1975). This construct evaluates the level of confidence felt when health practitioners have to undertake recommended preventive security control. Self-efficacy has been studied by numerous researchers in information technology adoption and behavior (Siponen et al. 2014).

The confidence level of the person is related to their mental attitude and determination. Embarking upon a Ph.D. does require one to visualize themselves completing the degree. They must have a certain level of confidence or self-efficacy within their self to keep propelling forward each semester. Rehearsing to one's self that they are capable and they have the ability to do so will replenish their mental fortitude and focus required for the rigors of such a program. Somewhere along the way, they will hear or see certain body language that will suggest that maybe they can't make it. Establishing and re-establishing your positive mental mindset is how they will combat negativity and discouragement along the way.

Self-efficacy is the engine which drives them to succeed against all odds. Self-efficacy generates stamina. Just when they think that they can't go any further or they want to give up – self-efficacy rises up. It enables them to overcome hurdles and looks for innovative solutions to complex barriers that may be in their way. It doesn't except any excuses and it can't be done" is not in its vocabulary.

2.2 Mentorship – Academic Support

Though mentoring is often cited as among the most influential factors on degree completion, that influence is difficult to assess. Mentoring is also an area that can pose unique challenges to universities seeking to implement program-level or university-wide improvements. For example, while research supervision is a formal responsibility of graduate faculty, and is recognized as such within the administrative structure and tenure and promotion processes for faculty career advancement, often universities do not have similar formal structures to require and encourage "mentoring," which is sometimes thought of as going above and beyond the

call of research supervision duties (King, 2003). On the other hand, because mentoring is practiced and valued unevenly in doctoral programs, and because student expectations of mentors differ, it is not surprising that students report having unequal access to quality mentors as they pursue their PhDs. (Mosley & Hargrove 2015)

Therefore, selecting an effective mentor requires one to take the time to conduct a mentor background check in order to establish a solid student-mentor relationship. The mentor should be available to answer questions, provide guidance, and assist in managing time so that all deadlines and deliverables are met. The mentor should provide periodic feedback at each juncture of the dissertation process. A Ph.D. student should not find out after he or she has implemented their methodology that their research is inadequate or the sample size is too small. Corrective advice should be given early on so that they can make the necessary corrections sooner than later. This requires the full attention of the mentor. If a mentor is mentoring more than five Ph.D. students – one should rethink this and ask themselves the question – is this working for me? If not, they should seriously consider finding another mentor. Research should be closely related to the field of expertise of the mentor so that they can truly guide your thoughts and ideas to making a significant contribution to the field. An excellent mentor will help navigate one thru the writing process, dissertation, and defense.

2.3 Family – Emotional Support

A family can play an important part in supporting a member who is aspiring for a higher goal in life. There are many family dynamic structures but regardless of the structure or make-up of the family – these individuals closest to you can offer you the best encouragement mentally and emotionally needed for this journey. It some cases it may be that they have personally attained a certain goal themselves and are reaching down to pull a family member up or the situation could be reverse and they are down and pushing the family member up and above them, most of the times this is the way it is among Latinos and African Americans.

Family support can come in many ways. It can be as simple as a pat on the back, a telephone call, an encouraging card or a cooked dinner. Support can be having someone to help pick up the kids from school, help the kids do their homework, help with the household chores. Support can even be a companion noticing that you are on the verge of being overwhelmed and taking the time to whisk you away for an evening night out so that you can emotionally regroup. Support can even come when your little one gives you thumbs up and smile. All these are examples of family support.

2.4 Study Groups – Cognitive Support

The feeling of Isolation and not belonging to a "study group" among doctoral students is a major factor that contributes to the high attrition rate at doctoral programs. Yet despite this recognition, the feeling of isolation has yet to be addressed fully in the design of some doctoral programs. In other words, most programs do not include specific design features that help to handle this feeling among matriculated students (Bess, 1978; Hawlery, 2003; Lovitts & Nelson, 2000).

In a study conducted by Dr. Ali, he noted that the feeling of isolation takes place at different stages in the doctoral program and is manifested in various ways. There are two particular issues that contribute to the development of isolation feeling among doctoral students. First, students begin feeling isolated because of confusion about the program and its requirements. What may start as simple confusion about the program or the requirements of the program quickly grows into a feeling of being left behind and overwhelmed.

Second is the lack of (or insufficient) communication that may take place during various phases of the program. Lack of communication takes place on two fronts: student-to-student and student-to-faculty communication. The basis for isolation revolves around these three issues: lack of communications, miscommunication, and confusion. Furthermore, isolation is felt differently at various stages in the doctoral program. Attaining the doctoral degree involves a different journey than prior those taken in the pursuit of Bachelors or Masters degrees. Therefore, a different set of intellectual and psychological demands is placed on the students. Hawlery (2003) explain the difference of both demands: "In most disciplines, the Ph.D. is considered a research degree and means that its primary purpose is to not prepare practitioners, clinicians and teachers, but to produce scholars. If you want to be considered a scholar, you must do research." The adjustment process as noted places a psychological burden that some students may find themselves unprepared for. This combined with the fact that most doctoral departments leave students to

deal with the psychological aspects of adjustment to themselves. So the students, who are less prepared for this psychological adjustment, may find themselves left behind, isolated and as a result, may drop out of the program. Given that each student takes the exam alone, in isolation, it separates each individual student from another contributing to feeling behind, overwhelmed and isolated. (Mosley & Hargrove, 2015)

Discussing these issues and concerns with other students will certainly help you to navigate thru this adjustment phrase. Encouragement can be found within a group as well as a resource for studying. Finding a group to study with or discuss adjustment issues with can be difficult. However, offering to take notes for the study group or presenting some skill that is useful for all will enhance your chances of being accepted and being accepted within a group.

2.5 Time Management & Financial Support

Management of your time and financial planning is vital to you completing on time and with minimal debt. Being accountable to your mentor and family is one way to keep track of your degree progression. Keeping a weekly log of what you have accomplished with help you manage your goals. Establishing a budget plan and allocating monies for each year of study will also help you to control financially as well as ease your mind while working towards the degree. Stress occurs when you don't have a grasp on your time or finances. Discussing strategies for handling time and money will enable you to concentrate on studies and degree completion as oppose to worrying and being stress-out to the point where you are unable to do anything.

3. CONCLUSION

There are a myriad of reasons why Hispanic students abandon Ph.D. degree programs. All of these reasons for failure are addressed when a Ph.D. support network infrastructure is established. With family support and excellent mentorship you will have the necessary emotional encouragement to continue and sustain mental fortitude throughout the program. Selecting the "right" study groups and creating ones to service the student will help the student in navigating thru the complexities of the subjects as well as prepare you for the qualifying exams. Addressing financial and time management issues early on and developing a strategy for the duration of the degree will eliminate the need for worry and stress. Each student must design and customize the network for their needs and Ph.D. program culture. However, all five nodes need to be synchronized with the vision that you are on the road to earning a Ph.D. Each has a specific function and role and if at any time, you feel the node isn't functioning like it should – you need to make adjustments immediately.

Support systems are valuable and needed for successful completion. Refusing help or advice from anyone does not mean that one will be fail – but it will take one along detours that could be avoided. Support is like a ladder, each rung propels one upward. Support is a wonderful commodity that works like money. It takes time to build and grow but eventually when you need to cash it in you will have what it takes to make it happen. Money does not grow on trees and neither does support. Becoming rich doesn't happen overnight and neither does a support system. It is acquired over time with hard work and patience. It is an investment.

4. ACKNOWLEDGMENTS

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Supporting Doctoral Degree Completion for Underrepresented Minorities for STEM Fields

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ABSTRACT

This article reports on findings from the Doctoral Initiative on Minority Attrition and Completion (DIMAC) (NSF grant # 1138814). It argues that the proportion of underrepresented minority students in the advanced STEM workforce could be increased by addressing late-stage attrition in STEM PhD programs. However, more research is needed to determine which strategies best counter late-stage attrition for doctoral students, and how they might be brought to scale.

Keywords

Underrepresented minority, first-generation, graduate students.

1. INTRODUCTION

Despite modest progress over the last decade, Hispanic and other underrepresented minority students remain precisely that: underrepresented at each stage of the doctoral student career and beyond. For example, between 2005 and 2015, the average annual increase in first-time graduate enrollment of Hispanic/Latinx students was 7.5%. In fact, between 2014 and 2015, the fastest rate of growth in first time enrollment - 7.6% - occurred for this group. Nevertheless, Hispanic/Latinx students still only constitute 9.6% of the total enrollment of U.S. citizens and permanent residents, a percentage share significantly below their representation in the larger population (Okahana, Feaster and Allum 2016). Collectively, members of underrepresented minority groups only make up 9.7% of doctorally-prepared STEM faculty and 7.9% of doctoral-level employees in the nation's total science and engineering workforce (National Science Board 2014).

2. STATEMENT OF THE PROBLEM

Postdoctoral appointments represent common first academic placements and are the main pathway to faculty careers in STEM fields, especially in the biomedical sciences. And yet the vast majority (80%) of institutions report that 10% or less of their postdocs are from underrepresented groups (Ferguson et al., 2014). Given the evidence that groups composed of individuals with diverse backgrounds are more innovative and better at problem solving than groups lacking in diversity (e.g., Loyd et al., 2013; Page 2008), it is clear that the health of the US scientific ecosystem crucially depends on our ability to escalate the rate of increase in individuals from underrepresented groups pursuing and earning advanced degrees.

Graduate diversity efforts often are largely directed towards the recruitment of larger, more diverse applicant pools. However, results from the NSF-funded Doctoral Initiative on Minority Attrition and Completion (DIMAC) (NSF grant # 1138814) point to the equal importance that efforts focused on timely degree completion must play. The following is a summary of several of the key findings from that report (Sowell, Allum, and Okahana 2015).

3. RESULTS FROM THE DIMAC STUDY: A FOCUS ON LATE STAGE ATTRITION

At seven years, the STEM doctoral completion rate for Hispanic/Latinx students is 48%. In contrast, seven-year completion rates for African American students is 40%. The most comparable data for majority students is derived from Sowell et al., 2008, which reports seven-year completion rates for majority students of approximately 46%.

One issue to consider is the long tail of PhD completion, or prolonged time-to-degree. Between years seven and ten, for example, for both African American and Hispanic students, there is an additional 12% increase in completion rates.

A separate issue to consider is attrition, and the timing of attrition, for Hispanic doctoral students. The seven-year attrition rate for Hispanic/Latinx students is 35% and for Black/African Americans it is 38%. Although there is variability by STEM disciplines, the median time to attrition for the underrepresented students in this study was 23 months.

Early attrition is generally considered preferable to later attrition. Nevertheless, the substantial attrition that occurs within the first two years of study points to the critical importance of bridge programs, early efforts to promote peer support, and good advisor-advisee relationships, including the clear communication of both formal and informal expectations.

However, nearly half of all underrepresented students leave doctoral study after completing coursework and other major milestones. Student survey data and focus groups clearly indicate that it is during the dissertation writing stage that students: feel most isolated (45% feel isolated from other students; 17% do not feel meaningfully integrated into the program), are more often worried about their mental and physical health (65% occasionally or frequently worry), and are least likely to believe that program faculty understand the issues that URM students are facing (30% disagree or strongly disagree) or that the program is doing a good job supporting their success (20% disagree or strongly disagree).

If "late-stage" attrition rates could have been cut in half, based on the 21 universities participating in the DIMAC study alone, there would now be an additional 689 African American and Hispanic/Latinx STEM doctoral degree holders eligible for faculty positions and other leadership roles in the advanced STEM workforce.

4. CONCLUSIONS

To have such an impact, we need to better understand how much of late attrition is preventable and what interventions are most effective in supporting late-stage persistence and completion. There is an emerging consensus about the important of professional development programs, for example, as well as dissertation writing boot camps and policies and technologies designed to track and facilitate student progress in the late stages of doctoral study. There is some thought that participation in professional development for non-academic careers may dissuade ABD students who decide the academic path is not for them from leaving doctoral study. However, there is little empirical research that documents the overall impact of these programs or, indeed, of those designed to prepare students for future faculty careers. Results from Sowell et al. (2015), Lovetts (2001) and others find that even though students are generally satisfied with the support they receive from their programs and faculty, they become increasingly skeptical in the latter stages of the doctoral process. Furthermore, students in the dissertation stage appear to increasingly rely on more informal support mechanisms, advocates/champions, and personal determination. Programs that buttress peer support networks and recognize and reward champions appear highly promising, especially in conjunction with efforts to improve faculty mentorship. But once again, we know very little about the formats, delivery modalities, timing, and other mechanisms that might make these initiatives more or less effective. Additionally, universities continue to struggle with bringing most of these programs to full scale and making them sustainable. Clearly, more research is needed and more work needs to be done to align efforts across the various sectors of higher education – including community colleges where many Latinx students begin their academic careers and the large research universities where they will receive their degrees, as well as the organizations – academic and non-academic – that will employ them.

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Expanding Pathways to the Ph.D.: Recruitment and Retention of URM STEM Graduate Students

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ABSTRACT

The United States is facing a shortage of highly skilled STEM professionals, especially in the computational sciences. Increasing the numbers of students from social groups underrepresented in these fields is of critical importance, yet we have seen little progress to date. This essay examines recruitment and retention of underrepresented minority graduate students in STEM fields, with particular attention to first-generation and undocumented students. It concludes with consideration of preliminary results from an Innovations in Graduate Education National Research Training grant designed to increase retention of underrepresented groups in the computational sciences.

Keywords
Retention, attrition, underrepresented minority, first-generation, undocumented, graduate students, innovation

1. INTRODUCTION

Recruitment of domestic students into STEM graduate programs has lagged in recent years, especially in engineering, mathematics, and computer science. The problem does not go away after admission, as retention rates for domestic students continue to be problematic for a variety of reasons. This pattern is exacerbated for members of underrepresented groups (Sowell et al., 2015).

2. THE PROBLEM

Across all science and engineering fields, the percentage of international graduate students increased between 2010-2015 from 29.9% to 38.1%. Among doctorate-granting institutions, the percentage of international students is slightly higher, at 31.1% in 2010 and 39.4% in 2015. In comparison, the percentage of underrepresented minorities (URM) has remained very small. Between 2010-2015, enrollments of African Americans in science and engineering graduate programs decreased slightly, from 5.6% to 5.0%, even as enrollment of LatinX students increased from 5.1% to 6.1%; when only doctorate-granting institutions are considered, the percentage of LatinX students increased from 4.8% in 2010 to 5.6% in 2015, but the percentage of African American students further decreased, from 5.2% to 4.3%.

This pattern is even sharper when we consider computer science programs, with international students comprising 64.0% of all computer science graduate students in 2015 compared to 49.2% in 2010. In contrast, the percentages of both LatinX and African American graduate students in computer science programs decreased slightly during the same period, from 2.8 to 2.6% for Hispanics and from 4.3% to 4.2% for African Americans (NSF 2015, Tables 13 and 18). This decrease occurred even as Latino representation in the overall U.S. population is climbing (Santiago, Taylor and Galdeano, 2015).

Targeted outreach is required to recruit LatinX and other underrepresented minorities into STEM graduate programs. But that is only the beginning. Once in graduate school, attrition rates for members of underrepresented groups surpass those of other domestic and international students (Castellanos et al., 2006, Green and Scott 2003, Sowell et al. 2015). As Figueroa and Hurtado suggest, “counter to the dominant narrative, URM students are not dropping

out, but are being pushed out of their STEM graduate programs by academic environments that lack full acceptance and encouragement of diverse students" (Figueroa and Hurtado 2013, 24-25).

3. ATTRITION AND COMPLETION RATES FOR UNDERREPRESENTED MINORITIES AND FIRST-GENERATION GRADUATE STUDENTS

The most recent data from the Council of Graduate School's *Doctoral Initiative on Minority Attrition and Completion* (Sowell et al. 2015) demonstrate that although completion rates are improving overall, racial/ethnic differences persist after controlling for gender and field of study (2015, 20). Moreover, completion rates are lowest in the physical and mathematical sciences (2015, 22), further contributing to the shortage of URM Ph.D.s in STEM fields. More specifically, of the 3,829 URM STEM doctoral students in their study, 44% earned doctorates within 7 years, 36% had dropped out, and 20% were still continuing their studies (2015, 15).

Seven-year completion rates among URMs were highest for the life sciences (52%), followed by engineering (48%), social and behavioral sciences (39%), and physical and mathematical sciences (38%); conversely, attrition rates were highest for the physical and mathematical sciences, with 47% leaving without their Ph.D. within 7 years, followed by engineering (36%), social and behavioral sciences (33%), and life sciences (31%) (2015, 16). These figures largely parallel patterns for all students by field, but the overall 7-year completion rates are higher for the overall population than for URM students, at 54% for engineering, 53% in life sciences, 48% in mathematical sciences, and 40% in social sciences (Sowell et al. 2008, 37). Completion rates also differ by gender, with slightly higher success rates for female URM STEM students (45%) than their male counterparts (42%) (2015, 16-17), and by race/ethnicity, with higher 7-year completion rates for Hispanic students (48%) than Black students (40%) (2015, 17).

3.1 First-Generation Graduate Students

Many underrepresented minority graduate students are the first in their families to attend college, never mind graduate school. While most research involving first-generation students focuses on undergraduates, many of the academic issues confronted by first-generation undergraduates are also applicable to graduate students. Family support can be a critical component of retention and success, but when family members lack information and personal experience in graduate education, especially at the doctoral level, their ability to provide practical advice about graduate school and career options may be limited (Sowell et al. 2015, Sowell et al. 2009).

First-generation graduate students may be unfamiliar with many taken-for-granted processes and procedures of graduate education, such as teaching and research assistantships, or when and how to submit papers to conferences (Gardner 2013). They also struggle with issues related to financial support, including higher debt for student loans than their non-first-generation peers (Hoffer et al. 2003).

First-generation students tend to be drawn to applied degree programs or fields in which they can clearly impact the world around them (Gardner 2013). As undergraduates, they may have focused more on completing their courses and earning their degrees than on gaining knowledge and making social connections that would prepare them for graduate studies. As a result, they may struggle with the long time frame and lack of immediate, practical results associated with some graduate programs. In addition, underrepresented minorities and first generation students often have multiple demands on their time due to family and community responsibilities (Kniffin 2007).

Like underrepresented minority and female STEM graduate students more generally, first-generation students frequently experience a sense of "otherness" and isolation in their graduate programs, as well as multiple instances of micro-aggressions within the university community (Brunsma et al. 2017, Figueroa and Hurtado 2013, Gardner 2013). Perhaps for these reasons, data from the 2014 Survey of Earned Doctorates indicate that first-generation college students who continue to graduate school took longer than other doctoral recipients to complete their

degrees (NSF 2015, 12). In general, then, the sociocultural conflicts faced by underrepresented minorities, many of whom are also first-generation students, do not disappear in graduate school (Kniffin 2007) and are likely to be compounded while pursuing graduate education (Lunceford 2011; see also Castellanos et al. 2006, Green & Scott 2003).

3.2 Undocumented Graduate Students

While research on the experiences of undocumented graduate students is lacking, it can be anticipated that these difficulties will be exacerbated for this population. Family responsibilities, for example, become even more intense for undocumented students when a parent is detained or deported, often leaving them with responsibilities for younger siblings (Zatz and Rodriguez, 2015). And, while all students risk encountering an unsupportive advisor, if students are unsure of their advisors' views on immigration policy, or if they know the advisor holds negative views on immigrants and immigration, undocumented students may not feel that they can reveal their status to their advisor. Finally, if a student does not qualify for Deferred Action for Childhood Arrivals (DACA) they cannot hold a teaching or research assistantship, thereby depriving them of a major source of professional development as well as funding. A likely ramification of these challenges is higher than average attrition rates.

4. BEST PRACTICES TO MINIMIZE ATTRITION AMONG URM GRADUATE STUDENTS IN STEM FIELDS

The landmark study on doctoral attrition among URM graduate students was conducted by Sowell, Allum and Okahana, (2015) for the Council of Graduate Schools. Based on surveys of doctoral students, enrollment data, and program inventories from 21 institutions over a 10-year period, as well as focus groups and interviews with students and university personnel during site visits to 16 universities, Sowell and his colleagues suggest a number of policies and practices designed to enhance recruitment and retention of URM doctoral students. More specifically, they identify the following best practices: (1) interventions throughout the doctoral process; (2) enhanced academic support such as peer mentors, peer support groups, and dissertation boot camp; (3) programs to help faculty to become better advisors; (4) monitor and evaluate programs and interventions; and (5) cultivate a culture of diversity and inclusion. Sowell et al. also recommend best practices in recruitment and selection of students; improvements to acclimation (specifically the student-advisor relationship, understanding expectations, and social interactions with faculty and peers); providing information about fellowships, special programs, and other opportunities; and multiple mentors and champions who will watch out for URM students. Finally, they point to the critical importance of mentors understanding the unique challenges confronting URM students and meeting frequently with their mentees (2015, 47; see also CAHSI 2015, Gates et al. 2011, Green & Scott 2003, Mosley & Hargrove 2015, and Santiago et al. 2015).

5. INNOVATIVE PRACTICES TO REDUCE ATTRITION

The University of California, Merced is modeling many of these best practices. While only 11 years old, this Hispanic Serving Institution and Minority Serving Institution has already received a Carnegie Classification of Research High. Like many other institutions, two years ago we implemented what is now a very popular Dissertation Boot Camp, and last summer we piloted a Summer Bridge program designed to give underrepresented minority and first-generation graduate students a competitive edge as they begin their doctoral studies. We plan to expand the Summer Bridge program this year, as students and faculty alike gave it very positive ratings. We also implemented a peer mentoring program for all new doctoral students this past fall.

Beyond these programs, which have proven to be successful in many institutions, we also designed and implemented an Innovations in Graduate Education National Research Training program in Interdisciplinary Computational Graduate Education with support from the National Science Foundation, Fourteen first year doctoral students meet every Friday afternoon for three hours. They are working in interdisciplinary teams on computational projects, and receiving instruction on coding in a number of languages and platforms, on how to succeed in graduate school, and on project management and team science. Of the students in our initial cohort, 29% are

Latino, 36% are female, 50% are the first generation in their family to go to college and another 29% are the first to attend graduate school. Ten faculty take turns teaching the instructional modules and mentoring the students (a minimum of 4 or 5 faculty are present at each class). The students receive social support, mentoring from faculty outside of their fields and from scientists in industry and the National Labs, and preparation for jobs in industry or the Labs or, as faculty, to be successful partners with these scientists. They send regular project updates to their external mentors, and in so doing they are solidifying these relationships, building networks, and gaining confidence in their abilities to engage in computational research individually and as part of teams. They will have opportunities to visit the National Labs and industries, to apply for internships with our partners, and to present their research at national conferences. While we are still in the first year of the project, we are already seeing signs suggesting that this innovative system of support and interdisciplinary instruction will reduce attrition rates among URM, female, and first-generation students in the computational sciences.

6. CONCLUSIONS

There is a national imperative to increase the number of professionals trained in STEM fields. Yet traditional faculty recruitment methods tend to favor their own networks, and the long apprenticeship of graduate school is not particularly inviting to many. If we are to increase the diversity of our graduate student population and open these fields to broader participation, we must take intentional action. We must not only widen the pipeline to graduate school, but also recognize and support the multiple pathways by which our students reach graduate school. And, we must recognize the external pressures and responsibilities which could derail or slow their progress. This is not just the responsibility of individual students; educational institutions must become active change agents, employing best practices and constantly innovating to find new models for ensuring the success of our students. We are making progress, but we must do more.

7. ACKNOWLEDGEMENTS

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NOTES

NOTES

INDUSTRY PARTNERSHIPS: STRATEGIES FOR FINDING A DIVERSE WORKFORCE

Moderator: Danny Olivas, University of Texas El Paso
Panelists: Eddie Grado, Joseph Michaels International
Luis Rodriguez, International Business Machines
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Research in technology and other STEM industries has revealed that workforce diversity contributes to innovation, yet recruitment of Latinas/os and other underrepresented minorities into STEM industries continues to present a challenge. There is also some research suggesting that Latinas/os who enter industry after making it through the STEM educational pipeline leave at alarming rates for other types of careers, possibly due to an unwelcome racial/ethnic climate. For Latinas and women from other underrepresented minorities, there is the added stressor of gendered exclusion in the workplace.

Research on underrepresented minorities in the STEM industry has discussed their feelings of being both invisible, and highly visible; invisible when icomes to opportunities such as promotions and special projects, and highly visible when companies search for someone to increase diversity in the workplace. Underrepresented minorities, including Latinas/os, are often saddled with the work of increasing diversity, as they simultaneously struggle to be recognized as a vital part of the innovation team.

The panel will be asked to reflect on successful and not so successful models for partnerships with academia at all levels and why the models have worked or not worked. In addition, the panel will address what an ideal alliance of partners looks like to achieve collective impact in diversifying the STEM workforce.

CAHSI-INCLUDES
Center for the Advancement of Space Safety and Mission Assurance Research (CASSMAR)

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ABSTRACT
Recognizing the importance of interdisciplinary engagement in the setting of post academic student pursuits, The University of Texas at El Paso is employing a unique center, focused on human space flight, to merge advanced degrees with real world experiences. Through industrial, government and academic collaboration, student researchers are provided with opportunities for practical industrial applications with an emphasis on cross functional collaboration to aid in problem solving and embracing diversity of thought. This concerted effort to provide beyond the traditional research experience has resulted in students taking advantage of well-defined career on-ramps, from academia to industry, with a core appreciation for the interdisciplinary nature of the real world.

Keywords
Human spaceflight, interdisciplinary, risk assessment, mission assurance, STEM education

1. INTRODUCTION
The University of Texas at El Paso (UTEP), a Hispanic-Serving Institution, serves the El Paso – Ciudad Juarez border region and has an 80% Hispanic student population. The University enrolls over 23,000 students and has significantly increased its research infrastructure and portfolio in the last decade. Building upon this growth, faculty and staff at UTEP have actively and consciously involved the diverse student population in a variety Science Technology Engineering and Mathematics (STEM) programs, with many focused on engaging students at all levels in research. These programs have been funded through external grants, cooperative agreements, and strategic partnerships across STEM departments in three UTEP colleges (Science, Engineering, and Liberal Arts), all leveraging the unique student population along the border.

We report on a specific effort at UTEP, specifically on an interdisciplinary center that formed from a strategic partnership between UTEP and Jacobs Engineering at the NASA Johnson Space Center, called the Center for the Advancement of Space Safety and Mission Assurance (CASSMAR). The mission of the CASSMAR is to produce and provide the latest advances and understanding of risk reduction to the field of human space flight and exploration; to education and train an interdisciplinary workforce that is equipped to push this new field of expertise to its full potential; and to develop partnerships with government and commercial space organizations necessary to exchange cutting edge knowledge and experience about safety and mission assurance on all facets of commercial space flight.

CASSMAR was founded as a research arm of the the Cyber-ShARE Center of Excellence: A Center for the Sharing of Cyber-Resources to Advance Science and Education, a National Science Foundation Centers of Research Excellence in Science and Technology (CREST). This interdisciplinary center fosters collaboration among earth, environmental, mathematical, and computer scientists, and allowed for the growth of CASSMAR as an interdisciplinary research center on campus. This paper outlines the history, activities, partnerships, and leading-edge research being conducted at CASSMAR.

2. BACKGROUND

The United States needs to increase the number of awarded STEM undergraduate degrees by about 34% annually over current rates [1]. The high demand for scientists and engineers in the workforce means more effective strategies are needed to increase student completion in STEM majors. Furthermore, there is a fundamental and urgent need to improve the learning and professional success of Hispanic graduates, the fastest growing demographic in the US and predicted to be a majority in the US by the year 2042 (U.S. Census Bureau). For example, the numbers of PhD's in science and engineering granted to Native Americans and Latinos have increased only slightly since 1975 [2]. Recent research, however, indicates that research experience, quality mentoring, and career development and training are incredibly valuable in increasing the success of underrepresented minorities [3].

Since HSIs enroll almost half of all Hispanic college students and a disproportionate number of Hispanic students enrolled in graduate STEM programs [4], HSIs must play an important role in diversifying the STEM pipeline. According to a 2015 report from Excelencia in Education, UTEP was among the top three leading producers (after Stanford and U.C. Berkeley) of STEM PhD graduates in the 50 states [5]. The current demographics of the El Paso region are poised to become the future demographics of the southwestern U.S.: more than 80% of school children are Hispanic, more than 60% of teachers are Hispanic, over 75% of undergraduate students at UTEP are Hispanic [6,7]. Thus, by building strong research and training programs, UTEP can significantly impact the diversity of the future STEM workforce.

3. INTERDISCIPLINARY APPROACH

3.1 Experience in industry

As in virtually every STEM industry, success is less a function of the novelty of the innovation, but more a function of the effectivity of a cross functional team to vet, evaluate, exercise and challenge the innovation. Organizations that can harness the power and creativity, which comes from diverse thought, typically arrive at solutions which no one individual is capable acting alone. The value that comes from cross-cultural and multi-disciplinary approaches to problem solving has been appreciate in academia going back to 1969 and earlier [8]. However, traditional academic settings are strained to fit into the curriculum, the minimum necessary to be technically competent, while spending little to no time to appreciate the need and value to approach problems using an interdisciplinary approach.

3.2 Cyber-ShARE

Cyber-ShARE is a focused, interdisciplinary research center that consists of computer resources and infrastructure, graduate and undergraduate students, interdisciplinary curriculum support, and a research atmosphere that fosters collaboration among earth, environmental, mathematical, and computer scientists. The Center concentrates specifically on the aspects of cyber infrastructure (CI) that deal with software and middleware services and tools, with a focus on the development of scientific CI applications and on training the next generation of scientists who can effectively use CI to perform leading-edge science.

The original Center had three major research subprojects: geoscience iFuse, the data science iLink, and environmental science iSense. The iFuse subproject focuses on developing 3-D Earth models using novel approaches to merge multiple data sets, that will be a foundation for answering our fundamental questions. The data science iLink subproject aims to improve the efficiency and effectiveness of the discovery, integration, processing and interpretation of scientific data. The iSense subproject focuses on advancing the understanding of ecosystem processes using state of the art sensing technology and cyberinfrastructure.

Because of the interdisciplinary nature and unique partnerships, another project has originated out the the center, including iConnect and CASSMAR. iConnect connects institutional data, people, and expertise, and was developed from an NSF Innovations through Institutional Innovation (I-cubed) grant. CASSMAR, described below, stemmed out of a unique partnership with Jacobs Engineering at the NASA Johnson Space Center.

3.3 CASSMAR

The concept behind CASSMAR grew out of real world experience in our nation's human spaceflight agency, NASA. The intent of the center is to serve two primary functions: create an interdisciplinary center with a focus on reducing risks of human spaceflight endeavors; and, enhance the aerospace research portfolio at UTEP and thereby increase opportunities for students to engage in research activities in the spaceflight arena. With the ultimate vision of becoming an authoritative resource for human spaceflight risk mitigation research, CASSMAR was established in 2013 as a dedicated research arm in

Cyber-ShARE to leverage the existing the interdisciplinary structure and models for student engagement.

Given the inherent diversity of challenges facing human spaceflight stakeholders, which often originate from overlapping disciplines of science and engineering, CASSMAR was intentionally structured to facilitate collaboration with researchers and students from the Colleges of Engineering, Science, Liberal Arts and Business Administration. This makes CASSMAR uniquely capable of responding to the diverse research needs identified by the spaceflight community in the area of safety, reliability and mission assurance.

CASSMAR currently maintains four primary research thrust areas that align with identified risks to human spaceflight, each with cross-cutting elements spanning both the Colleges of Engineering and Science: (1) micrometeoroid and orbital debris (MMOD) hazards, (2) structural materials performance in extreme environments, (3) spacecraft stored energy hazards, and (4) planetary science and exploration. Expansion of the CASSMAR research portfolio would result from new primary spaceflight risk areas being identified through formal risk assessment efforts by government and private spaceflight stakeholders.

3.3.1 Government collaboration

An early research focus in CASSMAR involved a partnership with the Columbia Research and Preservation Office at the NASA Kennedy Space Center to perform detailed materials characterization of Space Shuttle *Columbia* artifacts recovered after the catastrophic re-entry accident on February 1, 2003, which claimed the lives of seven U.S. astronauts. CASSMAR was able to negotiate with NASA to loan several key structural subcomponents from *Columbia* which exhibited unique characteristics suggesting these materials underwent unexpected responses to the re-entry environment, which aligns with the third CASSMAR research thrust area identified previously.

The first wave of students in CASSMAR were dedicated to this specific research area, and were comprised of minority students from metallurgical, materials science and mechanical engineering and from the undergraduate through early Ph.D. levels. Seven of these students were invited to present their initial research findings to NASA subject matter experts at the Kennedy Space Center in August, 2014. To date, CASSMAR has facilitated the research and successful completion of graduation requirements of two Ph.D. students with topics focused on the *Columbia* artifacts, with two more successful Ph.D. defenses anticipated by the summer of 2017. All of the graduate research that has been performed to date on the *Columbia* artifacts has involved participation from undergraduate students through formalized research initiatives in collaboration with faculty advisors from the respective academic departments. Over half of those undergraduates have elected to continue their academic career as graduate students at UTEP in areas of research aligned with CASSMAR.

3.3.2 Industrial collaboration

Since its inception, one overarching goal of CASSMAR was to establish partnerships with government and commercial spaceflight organizations to identify primary spaceflight risk areas and implement formal mechanisms to functionalize research activity and student involvement. In September 2014, UTEP signed a 5-year contract with Jacobs Engineering as the prime contractor at the NASA Johnson Space Center (JSC) for approximately $1M/year. The contract specifically facilitates focused hiring of 6 NASA researchers actively supporting the JSC mission into specific CASSMAR research thrust areas. These researchers continue to perform daily functions at NASA JSC while servings as focal points for academic research collaboration between NASA and UTEP students and faculty.

One immediate positive outcome from the Jacobs-CASSMAR collaboration involves a new mechanism for student internship opportunities at NASA JSC, with both ‘forward’ and ‘reverse’ internship components. This model involves students relocating to Houston, TX for the summer to work side by side with one of the CASSMAR-JSC researchers for the ‘forward’ research component. This component gives the students an opportunity to integrate into the JSC organizational structure and receive tangible real-world working experience while developing a topic of research that directly supports NASA mission requirements. The ‘reverse’ component is activated as the students return to UTEP for the Fall and Spring semesters for coursework and continue to perform their JSC research remotely on a part-time basis while maintaining routine contact with their CASSMAR-JSC mentors via IT infrastructure and telecommuting agreements with NASA. As of February 2017, four CASSMAR students have either been actively participating in, or have completed, their internship experience via this model. Two of those students are on a path toward eventual

employment with NASA at JSC or the White Sands Test Facility.

3.3.3 Academic collaboration

Spaceflight endeavors remain successful in attracting student interest, particularly at the early and middle school levels. The visibility and accessibility to this industry that CASSMAR brings to UTEP has created new interest in academic collaboration with research groups across the university, most recently with the College of Education in partnership with local El Paso elementary and middle schools with a proposal to the Institute for Education Sciences on an initiative called PickSTEM [9]. This proposed initiative would use inquiry-based models centered on spaceflight themes to evaluate STEM curriculum design principles in the K-8th grade levels.

In the near future, CASSMAR will also be collaborating with faculty in the fields of systems and reliability engineering to develop curriculum on risk assessment and risk-based design to be integrated with existing engineering courses at the undergraduate and graduate levels. The intent of this curriculum is to reinforce the importance of effective risk assessment at all levels of design engineering, using actual case studies that were encountered during the course of the human space program, some of which involve active lines of CASSMAR research.

4. PLAN FOR THE FUTURE

The approach utilized by CASSMAR has garnered the interest of industries beyond human space flight. Industries such as defense, oil and gas, heavy industry and consumer products, have expressed an interest in collaboration. The value of transferring the lessons learned in human space flight through a cross-functional interdisciplinary approach, is easily appreciated. Considering the difficulty in achieving some of the most challenging objectives our time in human space flight, the methodologies applied to the most complex non-space challenges increases the likelihood of success. This industrial pull, in turn, provides for unique engagement opportunities for student researchers. The goal of the approach is provide an educational experience, which sets up the graduating students for success by immediately and effectively integrating into life beyond academia.

5. ACKNOWLEDGMENTS

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Is It Time for a Re-Alignment?

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ABSTRACT

We start with a traditional core diversity metric: counting the number of Latina/os who graduate from a 4-year college with a STEM degree, and move into stable employment. We then consider the key industry imperative of reaching business outcomes, and find it doesn't align well with the traditional diversity metric. We provide a point of view on this misalignment, plus three illustrative examples.

We also put forth four recommendations, for discussion, as ways to improve our ability to drive more Latina/o STEM leadership into industry.

Keywords

STEM Latino Latina college university business industry T-shaped start-ups “new collar”

1. MISALIGNED? BUSINESS OUTCOMES VERSUS DIVERSITY METRICS

Businesses live by the outcomes they deliver and sustain. Examples include revenue growth, profit growth, market share, transaction volume, scale, stock price growth, and competitive differentiation. These are ingredients of the "What" that businesses strive to achieve.

The "How" manifests itself in the approach and decisions that businesses make to achieve the "What." These include resource allocation, geographical focus, market segment focus, technology focus, and, of course, talent focus.

Going deeper on talent, businesses determine what kind of talent is needed based on what that talent is supposed to achieve. Does a business need technical skills to develop capabilities that provide competitive differentiation? If so, what are those specific skills, how do they attract and retain those skills, and how to they upgrade those skills over time?

At IBM for example, diversity is considered a business imperative. Since IBM depends on highly-differentiated technology to succeed, a key goal for IBM is to develop first of a kind technologies, unique technologies, and otherwise marketable technologies that sustainably differentiate IBM offerings. IBM considers diversity in its technology talent to be key to achieving this goal.

Given this premise, it is interesting to note that the goal of a technology-driven business is not aligned to the Diversity metric we've been asked to discuss: Increasing the number of 4-year college educated STEM Latino/as in industry. Businesses look at talent management from a skills perspective, whereas the aforementioned Diversity metric is narrow and constricting - it measures an academic process, rather than the ability to impact business outcomes.

This leads to our first recommendation: Rather than focusing on a 4-year college degree, focus on a journey of skill building. A 4-year college degree is certainly an important aspect in some journeys, but not all of them, and is not always immediately needed after high school.

To illustrate, we provide three examples where focusing on skills and business outcomes lead to more favorable outcomes for both businesses and for STEM-skilled Latina/os.

2. THE T-SHAPED STUDENT: BROAD COMPETENCIES + DEEP SKILLS

The T-shaped student concept has been around since at least 1991, but it doesn't seem to have caught on academically. The core idea being that a STEM student should not just be deep in a STEM area, they should also be broad in various disciplines. An example is a student who is deeply skilled at building complex scalable data structures for unstructured data, yet who also more broadly understands how that data is to be

monetized by the business. The broad, more business-like understanding of data monetization can inform technical decisions that impact security, privacy, and data location regulations, all very pertinent commercial concerns.

Part of the issue is that it is easy for academic institutions to focus on the 'depth' of STEM as a way to differentiate among other academic institutions. "We teach you more programming skills than anyone else." By doing so, domestic academic institutions leave our students especially vulnerable to international institutions that turn and churn out traditional skills at a frenzied pace — "I-shaped students."

These I-shaped students are not typically recruited as most likely to drive leadership, transformation, and change to achieve business outcomes. Rather, they are typically recruited to build, not innovate. This creates a misalignment between what a business really needs from our STEM students (T-shaped skills) vs. measuring a process (4-year college degree).

This leads to our second recommendation: Make "T-shaped" a key attribute of success for Latina/os who develop deep STEM skills.

For Latina/os in particular, the different perspectives and experience we bring can be brought to bear around the breadth of the "T": our way of collaborating, the way we approach business, how we approach problem solving, etc. This can help differentiate Latina/os more broadly, whereas just pure "I" technical depth is harder to programmatically cultivate into a potent differentiator.

3. START-UPS: CRUCIBLES OF CHANGE

Start-ups provide Latina/os two different avenues into industry. The first is by the very nature of a new start-up; the closer someone is to the 'ground floor', the better their chance of being a visible high contributor. The second is when a start-up is acquired into a larger company. The more Latina/os in the start-up, the more have opportunities to be hired en-masse into leadership positions and as experts.

Unfortunately, the numbers are not in our favor. Latina/os are not well represented in tech start-ups. This may also be cultural, as working for a large company that can provide a stable income is what many hope for in order to provide for their own and extended family. This may also be a partial consequence of the lack of emphasis on a "T-shaped" skill set for STEM-skilled Latina/os. Starting and running a successful business requires more than just deep STEM skills.

This is an area where help can be more readily provided. There are many examples of how colleges & universities, incubators, venture firms, chambers of commerce, and other entities help innovators to form start-ups. Interestingly, given our background, start-ups can offer Latina/os a way to differentiate given our background and culture. Mexico has a growing start-up segment, and many Mexican start-ups would love to have some kind of 'in' to the U.S. market. U.S. start-ups with enough bi-lingual and bi-cultural capability thus have a strong advantage when partnering with start-ups south of the border.

It should also be noted that developing entrepreneurial skills or achieving start-up success is not dependent on completing a 4-year college degree. In addition, a measure of 'scale' is needed to bring the right amount of attention/investment into a particular city or location to create a fluid start-up community.

This leads to our third recommendation: Designate and fund one or more "start-up cities" as locations to grow Latina/os start-up communities.

4. NEW-COLLAR WORKERS: A DIFFERENT JOURNEY

IBM is an example of a company that is looking at STEM skills and talent in a different way. For example, at some of IBM's U.S. facilities, as many as one third of the employees have less than a four year degree. An example of this kind of job is a web developer.

These jobs are referred to as "new collar" jobs. These are not 'mechanical' jobs taught by typical "trade schools." An example of the education process is "P-Tech," an IBM-sponsored holistic approach to education for "grades 9-14."

Starting salaries are competitive - for example, in IBM's cloud computing unit, some new-collar starting salaries are over $40,000 per year. Beyond providing hands-on experience, these jobs also require workers to increase their level of skill over time.

From a Latina/o perspective, this kind of opportunity can create a strong alternative journey when a four-year college commitment may be 'out of reach,' but where a two-year traditional 'trade school' approach doesn't create broader career possibilities.

With this approach, students can better overcome financial difficulties, can learn to be more T-shaped more quickly, can have an opportunity to transition to

start-ups, and can more easily get through a 4-year college degree later on with the experience they gain.

Thus, the approach becomes more about building skills in a hybrid and flexible manner that addresses various obstacles faced by Latina/os.

This leads to our final recommendation: Invest in rethinking a hybrid approach, combining ideas like "T-shaped," "Start-ups," and 'New Collar.' Endeavor to best help Latina/os to build more customized journeys to developing skills that play to our strengths and that also align to what industry considers differentiation of talent and skills.

Diversifying the STEM Professoriate: Defining the Issue at Hand

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ABSTRACT

This paper identifies the primary issues that have confounded efforts to increase the number and proportion of underrepresented groups within STEM faculty. Drawing on extant research, the paper establishes that despite increases in diversity and inclusion within other areas of academia, STEM fields continue to experience disproportional lags in diverse representation throughout the STEM pathway and especially within STEM academic careers. The paper argues that there are two primary foci that must both be addressed to achieve a diverse workforce: increases to the pool of credentialed candidates and a critical examination of the recruitment, hiring, and retention practices and policies. While this paper is focused within the context of higher education and the diversification of STEM faculty, its findings and argument are applicable for areas of industry beyond academic careers.

Keywords

Higher Education, STEM, Faculty, Diversity

1. INTRODUCTION

Broadening participation within STEM faculty is key to broadening participation in STEM fields and cultivating a STEM workforce able to tackle 21st century challenges. Research on increasing the success of underrepresented students has suggested that when taught by underrepresented faculty, underrepresented students achieve at significantly higher rates and as much as 20-50% of the course achievement gap between these groups and majority students disappears (Dee, 2007; Ehrenberg, Goldhaber, & Brewer, 1995; Fairlie, Hoffmann, & Oreopoulos, 2011; Hoffman, & Oreopoulos, 2007). Similarly, Price (2010) found that Black male and female students persisted at higher rates in STEM majors when taught by faculty with corresponding race and gender.

Despite the centrality of diversity in learning and student success, efforts to increase underrepresented faculty have been largely unsuccessful (Turner, Gonzalez, & Wood, 2008), particularly in STEM (National Academies, 2011; Nelson & Brammer, 2010; Nelson & Rogers, 2003). In 2013, 1.5 million faculty (tenured, tenure-track, contingent, and adjunct in all fields) were employed at degree-granting institutions in the U.S. (51% full-time; 49% part-time), and of those who were full-time faculty only 21% were non-White and 48.8% were female (NCES, 2015). Within STEM fields these disparities are even larger. The National Science Foundation (2015) reported that in 2013, underrepresented minority faculty occupied a mere 8% of associate and full professorships in STEM fields at 4-yr institutions.

National attention towards the issue of broadening participation in STEM pathways and the professoriate have resulted in a deeper understanding of the barriers

experienced by underrepresented populations (e.g., Hernandez, Schultz, Estrada, Woodcock, & Chance, 2013; National Academies, 2016; Tsui, 2007) and the creation of many programs aimed at enhancing the success of these students through STEM pathways—most specifically aimed at increasing underrepresented students' competitiveness within faculty markets; however, large-scale systemic change has been very limited (NCES, 2015; NSB, 2016). This begs the question, "Why has broadening participation not occurred in STEM faculty given the increases in our understanding?" The answer to this question is necessarily complex.

2. A BOTH/AND ISSUE

Opportunities to increase faculty diversity are partially limited by the number of underrepresented groups ready to pursue graduate programs in STEM (Knowles & Harleston, 1997; National Academies, 2016). While the number of first-time, full-time college students entering 4-year postsecondary institutions with STEM degree aspirations have increased by 10% in the past decade (NSB, 2014), overall STEM completion rates have remained stagnant and significant disparities continue between historically underserved students and their peers (Eagan, Hurtado, Figueroa, & Hughes, 2014; National Academies, 2016).

A growing body of literature has identified the barriers to persistence and enrollment in STEM graduate programs for underrepresented populations, including: classroom environment (National Academies, 2016), sense of belonging (Johnson, 2012; National Academies, 2016), finances and debt (Malcom & Dowd, 2012); academic challenges (Haak, HilleRisLambers, Pitre, & Freeman, 2001; Tsui, 2007; Villarejo, Barlow, Kogan, Veazy, & Sweeney, 2008; Stephan & Ma, 2005). Programs exposing students to academic research have perhaps been most often recommended, with researchers establishing relationships between participation and retention in STEM, graduate degree aspirations, and career interests in research for students from underrepresented backgrounds (Connolly, Savoy, Lee & Hill, 2016; Eagan, Hurtado, Chang, Garcia, Herrera, & Garibay, 2013; Espinosa, 2011; Jones, Barlow, & Villarejo, 2010; Pender, Marcotte, Domingo, & Maton, 2010; Russell, Hancock, & McCullough, 2007; Tsui, 2007). In addition, researchers highlight the importance of engagement in departmental or science clubs and organization (Espinosa, 2011), active learning in science classrooms (Haak et al., 2011), and encouragement and mentorship from faculty (Cole & Espinoza, 2008; Eagan et al., 2013; Tsui, 2007) in fostering STEM persistence and post-baccalaureate degree aspirations.

Increases in faculty diversity require increased persistence in STEM majors, interest in graduate education, and career aspirations in science for undergraduates from underrepresented backgrounds; however this is a necessary but insufficient focus.

The bulk of past research, and resulting initiatives, on broadening participation of underrepresented groups within STEM fields have primarily focused on increasing the pool of STEM graduates. Despite continued disparities in STEM degree attainment, these initiatives have in fact increased in number the proportion of STEM doctoral graduates from underrepresented populations. Yet despite these small increases, the number and proportion of diverse STEM faculty remain disproportionally limited. Why? Because to diversify the STEM professoriate, we must increase the pool of diverse STEM graduates AND critically evaluate the recruitment, hiring, and retention practices and policies for STEM faculty.

3. SYSTEMIC ISSUES IN RECRUITMENT, HIRING, & RETENTION

Scholars have highlighted how faculty hiring practices and policies can mitigate or exacerbate underrepresentation within the academy. Recent research from the Bureau of Labor Statistics has demonstrated that while the number of full-time faculty positions (tenure-track and contingent) has remained stagnant or decreased in the last decade while the number of Ph.D. candidates for these positions has increased creating a surplus of highly qualified candidates (Stephan, 2012; Xue & Larson, 2015). While research on this topic is mixed, some suggest women and underrepresented minority candidates are disadvantaged as processes become more competitive, as institutions send signals that there are shortages of qualified candidates from underrepresented backgrounds or make fewer efforts to recruit diverse candidates because they are perceived as "hard to get" and too costly (Kulis, Shaw, & Chong, 2000; Tuitt, Sagaria, & Turner, 2007). Some have also called attention to implicit bias in the hiring process, as search committee members (who are often White and/or male) unconsciously preference individuals that remind them of themselves and more critically assess the qualifications and scholarly pursuits of women and underrepresented

minority candidates (Hill, Corbett, & Rose, 2010; Reuben, Sapienza, & Zingales, 2014).

While there is little empirical work validating successful strategies, institutions able to increase faculty diversity report placing emphasis on diversity as a priority, and the implementation of strategic initiatives like search committee trainings about bias and diversity, pre-search campus visits with potential candidates, cluster hires, and strategic placement of advertisements in resources targeting women and people of color (Collins & Johnson, 1988; Glass & Minnotte, 2010; Kayes, 2006; Smith, Turner, Osei-Kofi, & Richards, 2004).

Increasing numbers of women and underrepresented minorities recognize the competitiveness of the faculty job market and are dissatisfied with the values and norms of academic science, which may dissuade many talented scientists from pursuing faculty careers. Recent research suggests that as students' progress through Ph.D. training, interest in pursuing academic research careers significantly decreases (Fuhrmann, Halme, O'Sullivan, & Lindstaedt, 2011; Russo, 2011; Sauermann & Roach, 2012). Declines may be particularly stark for populations underrepresented in the academy, with recent research showing underrepresented minorities and women, and underrepresented minority women in particular, having the lowest levels of interest in faculty careers at research universities at the end of their graduate training (Gibbs, McGready, Bennett, & Griffin, 2014). Scholars have connected these declines to a lack of alignment between trainees' personal values and the structural dynamics of the academy, namely low postdoctoral pay, high faculty workload, and decreased availability for grant funding as increased emphasis has been placed on scholarly productivity (Fuhrmann, Halme, O'Sullivan, & Lindstaedt, 2011; Gibbs & Griffin, 2013).

Only by focusing on both essential pieces of this issue—faculty pool building and critical examination of the recruitment, hiring, and retention practices and policies of STEM faculty—will diversification of STEM faculty be achieved.

4. A WAY FORWARD

Transitions from undergraduate into graduate STEM programs, graduate school into postdoctoral positions, and then from postdoctoral training to STEM faculty positions, represent critical junctures in STEM pathways. However, there is limited extant empiric literature on the forces, factors, and structures that facilitate these transitions throughout STEM pathways and across institutions towards faculty careers, nor whether or how these differ for persons from underrepresented backgrounds. Consequently, policy makers, universities, and scientific societies have a limited evidence-base from which to design, implement, and evaluate interventions that facilitate transitions along STEM pathways.

The goal of the Association of Public and Land-grant Universities' (APLU) NSF INCLUDES Project is to increase the number of STEM faculty at APLU member institutions from underrepresented and underserved groups: Women, members of minoritized racial and ethnic groups, persons with disabilities, and persons from low-socioeconomic backgrounds.

The project seeks to achieve this diversification through three project goals:

- Develop a set of diagnostic tools and practices to help institutions more effectively recruit, hire, retain, and support faculty from traditionally underrepresented populations within STEM.
- Identify and begin implementation of a series of transformative institutional activities aimed at increasing participation along the STEM pathways toward the professoriate in order to grow a more diverse pool of STEM students who can eventually become professors.
- Evaluate the adequacy and coverage of current data sources and metrics available to track the progress and success of STEM students from entry into postsecondary education through the professoriate.

Two particular areas of focus are the evaluation and revision of current faculty hiring practices and increasing career development and cultivating anticipatory socialization of underrepresented students into academic science and towards the STEM professoriate (Clark, 1983; Jahn & Myers, 2014).

The diversification of STEM faculty will contribute to broadening participation in the STEM workforce by directly increasing the number of underserved individuals in STEM faculty careers. A more diverse faculty would stimulate a larger secondary effect—or halo effect—by facilitating the increased interest and success of STEM students from underrepresented groups through experiences with a more nationally representative faculty (Antonio, 2000; Hagedorn, Chi, Cepeda, & McLain, 2007; Hurtado, 2001; Turner, González, & Wood, 2008). Moreover, the

diversification of STEM faculty and the STEM workforce will simply lead to better science, innovation, and our society's ability to tackle our most pressing problems and thereby improve the world we live in (Guterl, 2014).

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DISCUSSION: GRADUATE DEGREES

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