Meeting STEM workforce demands by diversifying STEM

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Executive Summary: Historically, the U.S. has been a leader in Science, Technology, Engineering, and Math (STEM). In an increasingly advanced scientific and technical world, the U.S. must remain an ambassador of STEM to retain a steady stream of STEM professionals. By the end of the decade, 1 million more STEM professionals are needed to meet rising workforce demand. In an effort to produce more STEM graduates, a push toward preparing and inspiring all students from diverse backgrounds will ensure a more qualified and diverse workforce. In this report, I recommend three actions to level the playing field for underrepresented groups in STEM. First, advocating for a change in paid parental leave; second, investing in programs that encourage a "STEM for all" approach; and third, provide greater financial resources to minority students. We are faced with an unprecedented opportunity, and an urgent need to transform STEM education. By diversifying our workforce, we will ensure another century of American prosperity.

I. Introduction: The problem

Throughout most of history, higher education and scientific innovation in engineering and technology were major drivers in the U.S. economy. By the end of the decade, 1 million more STEM graduates will be needed than the U.S. will create at current rates.[1] However, there are a variety of barriers in higher education—cultural, societal, and institutional— that lead to longer graduation times and lower retention among many racial and ethnic groups in science, technology, engineering, and math (STEM).[2] While the degree completion rate is less than 50 percent for all STEM applicants, the lowest completion rate is found among students from underrepresented backgrounds including black, Hispanic, and Native Americans.[3] A 2013 poll conducted by Brown University found that 45 percent of black students and 61 percent of Hispanic students felt "unprepared" to pursue a STEM degree, compared to 30 percent of white students.[4] Promoting students' sense of belonging in STEM is needed to create a community of scholars that more closely resembles the diversity of the U.S. As the world increasingly becomes technologically and scientifically advanced, STEM education will determine if the U.S. will remain a leader to solve complicated challenges in health, energy, food security, and national security. Quality STEM education in the 21st century must ensure broader diversity developments in order to meet rising workforce demands with a more qualified workforce.

II. Troubling signs

Estimates show the U.S. education system drove most of the nation's economic growth and prosperity in the

[1] President's Council of Advisors on Science and Technology (PCAST), "Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics," 2012.

[2] National Academies in Sciences Engineering and Medicine, "Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse Pathways" (Washington, D.C., 2016).

[3] National Academies in Sciences Engineering and Medicine.

[4] Isobel Heck, "Lacking Foundation, Minorities Struggle in STEM Fields," *The Brown Daily Herald*, October 31, 2013.

20th century.[5] Expansion of high school education and higher education systems produced a skilled workforce with improved intellectual capabilities. For example, between World War I and the end of the century, about a quarter of the growth of output per capita in the U.S. was attributed to improvements in labor quality due to superior education.[6] Despite great gains, the rate of increase of average years of education has leveled off in the last two decades of the 20th century. More specifically, in 1975, 30% of the world population accounted for U.S. college students. Now, the country claims merely 14%.[7] Due to a more balanced global workforce as underdeveloped nations join the global economy, U.S. workers are in direct competition with employees from other countries. In particular, China, South Korea, and Brazil have invested heavily over the past decade in higher education and in research and development (R&D).[8] These investments have changed the scientific and technological playing field as the Asia-Pacific region contributes a larger portion of global R&D than the United States as of 2014. Despite being a leader in STEM education historically, the U.S. now lags behind other countries in STEM education at the elementary and secondary levels. As grade level increases, U.S. students fall progressively lower on international comparisons of scientific and mathematical ability. Furthermore, the National Assessment of Education Progress (NAEP) shows less than one-third of U.S. eighth graders are proficient in mathematics and science, improving very little over the past few decades.[9] Over the past 10 years, growth in STEM jobs was thrice that of non-STEM jobs.[10] These jobs will increasingly require higher education training. By 2025, California may experience a shortage of qualified STEM workers with necessary education.[11] In order to fulfill the workforce demand, students from all backgrounds are needed in STEM.

III. Opportunity for growth

In the 21st century, the country's need for a world-advancing STEM workforce has grown and will continue to grow as other countries make rapid advancements in science and technology. Scientific advancement is dependent upon scientific talent; currently, the chronic and dismal underrepresentation of certain social groups and races in science in the U.S. represents a loss of talent. A Brookings Institute survey showed that in 2011 in the U.S., 22% of STEM workers were women (50.8% of the population), 10% Asian (5.6% of the population), 6% black (13.3% of the population), and 9% Hispanic (17.8% of the population).[12] According to data from the National Science Foundation, people with disabilities are just as likely to enter STEM fields as those without disabilities; however, students with disabilities are less likely to enroll in STEM graduate studies, which are often needed for top careers in STEM fields.[13] The next generation of STEM expertise will be increasingly diverse due to changes in societal norms, more women attending college, and increased presence of minorities and people with disabilities in higher education. Thus, the continued underrepresentation of minorities and women in science showcases an opportunity and challenge for the U.S. to cultivate a diversified scientific workforce.

IV. Preparing and inspiring students

Increasingly, all citizens will need to use scientific knowledge, advanced technological skills, and quantitative methods in their jobs and in their daily lives to make informed decisions about critical issues. We must first *prepare* all students to have a strong

[5] Claudia Goldin and Larry Katz, "The Race Between Education and Technology" 12984, no. 12984 (2008).

[6] David Mitch, "Education and Economic Growth in Historical Perspective," EH.net, 2005, http://eh.net/encyclopedia/education-and-economic-growth-in-historical-perspective/.

[7] PBS, "Achievement: STEM," 2008.

[8] National Science Foundation, "Revisiting the STEM Workforce: A Companion to Science and Engineering Indicators 2014," 2014.

[9] F Mary Williams and Carolyn J Emerson, "Science and Engineering Indicators 2010," 2010.

[10] David Langdon, David Beede, and Mark Doms, "STEM: Good Jobs Now and for the Future," *Economics and Statistics Administration Issue Brief* 03, no. 11 (2011): 1–10.

[11] UC Davis Office of the Provost, "STEM and the US Job Market," 2017, https://stem.ucdavis.edu/stem-and-us-job-market/.

[12] Jonathan Rothwell, "The Hidden STEM Economy," *Washington, DC: Brookings*, no. June (2013): 1–38, http://www.brookings.edu/~/media/Research/Files/Reports/2013/06/10 stem economy rothwell/SrvyHiddenSTEMJune3b.pdf.

[13] Halley Sutton, "Students with Disabilities as Likely to Enter STEM Fields as Those without Disabilities," *Disability Compliance for Higher Education* 22, no. 9 (2017).

foundation in STEM. Then, we must *inspire* all students to be excited about STEM and the opportunities in the field. Three main areas of national need are apparent:

i. Ensure a STEM-literate constituency.
All citizens will need to understand science and technology to succeed professionally and personally. Since every occupation has the potential to evolve by scientific and technological advancements, it is imperative that all citizens have a strong baseline in STEM. Even outside STEM occupations, the set of core cognitive knowledge, skills, and abilities associated with STEM education are in demand in nearly all job sectors and occupations. [14] Additionally, citizens should have the knowledge, problem-solving, and critical thinking skills that come from studying STEM subjects when making personal decisions, serving on a jury, or voting or running for public office.

ii. Cultivate a STEM-proficient workforce
The STEM proficient workforce currently includes as many as 21.4 million people—approximately 15% of the employed population. [15] Companies in STEM-related fields report shortages of skilled STEM workers and these shortages will continue to persist as employment in STEM fields increases. The U.S. education system must produce more skilled workers to ensure the country's future prosperity.

iii. Cut off the achievement gap
These STEM workforce needs cannot be met without drawing from the full potential of U.S. citizens, particularly women, underrepresented minorities, and people with disabilities. The future of STEM education in the U.S. must recognize, manage, and properly compensate untapped talent. STEM fields will greatly benefit from drawing on a diversity of perspectives, cultures, and ideas.[16]

V. Policy suggestions
Many policy suggestions thus far have concentrated on funding more STEM courses at all levels to meet rising workforce demands. While this is not inherently false, efforts are needed to target students at every zip code to provide enriched learning opportunities. Policies need to target the culture of minorities and women included in STEM. Therefore, three main policy suggestions are:

i. Improve legislation on paid parental leave and equal pay
Cultural stereotypes and norms have a large impact on women and their decision to raise children, particularly in STEM. The Family and Medical Leave Act of 1993 mandates a minimum of 12 weeks unpaid leave to mothers to attend to a newborn or newly adopted child. A study of Harvard Business School graduates showed that of 25,000 interviews with men and women who graduated from Harvard Business School, the male graduates were much more likely to be in senior management positions with more responsibility than their female peers. The authors found that these women made unexpected sacrifices at the expense of their career, often no longer considered for higher positions because of family responsibilities. [17] Similarly, a 2013 study found that 50% of female STEM professionals leave the field within 12 years, compared to less than 20% of women in other fields.[18]

Sweden sets an excellent example concerning paid parental leave, where the law gives parents 480 days off per child through age 8. Parents also receive 80% of their usual wage, with the cost employer and the state sharing the cost.[19] Paid paternal leave will help even the playing field for women in STEM by altering typical gender roles in society. Changing family leave and how fathers help care for children could help

[14] The United States Department of Education, "STEM 2026: A Vision for Innovation in STEM Education," *U.S. Department of Education Workshop*, 2016, 55, https://innovation.ed.gov/files/2016/09/AIR-STEM2026_Report_2016.pdf.
[15] National Science Foundation, "Science and Engineering Indicators 2008," *Science and Engineering Indicators*, vol. 1, 2008.
[16] President's Council of Advisors on Science and Technology (PCAST), "Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America's Future," 2010.
[17] Robin J. Ely, Pamela Stone, and Colleen Ammerman, "Rethink What You 'Know' About High-Achieveing Women," *Harvard Business Review*, December 2014, https://hbr.org/2014/12/rethink-what-you-know-about-high-achieving-women.
[18] Jennifer L Glass and Sharon Sassler, "What's So Special about STEM? A Comparison of Women's Retention in STEM and Professional Occupations" 92, no. 2 (2014): 723–56, https://doi.org/10.1093/sf/sot092.What.
[19] Alexander Abad-Santos, "The First Step to Having More Women in Science Is Maternity Leave," *The Atlantic: Politics*, October 7, 2013.

women aiming toward high-powered jobs in STEM. Only four states—California, New Jersey, Rhode Island, and New York—currently offer paid family and medical leave. These programs are paid for by employee-paid payroll taxes.

ii. Invest in programs that encourage "STEM for all"

Myriad reasons have been cited for the decreased retention of minorities in STEM—from poverty and discrimination to lack of support networks and reduced high school resources and enrichment opportunities.[20] Programs that seek to encourage all students to engage in STEM have demonstrated that out-of-school and extended day activities can spark interest and enthusiasm in STEM. These programs also provide valuable mentorship and encouragement opportunities, which has shown to be a positive contributor in the decision to pursue a career in research. [21] For students from underrepresented minority groups, mentorship has been shown to enhance recruitment to graduate school and research-related pathways.[22]

For example, Project Exploration [23] , a nonprofit science education organization, offers underserved communities, free-of-charge science programs to more than 250 public schools. Participation does not require previous success in academics; rather, all children are invited to explore science with their peers under the guidance of role models and instructors. Eighty-five percent of participants are from lower income families and 60% are pursuing or received degrees in STEM.

Data also shows rural schools are especially challenged in meeting national STEM benchmarks.[24] States and school districts are challenged to adopt courses needed to develop and deepen student's interests in math and science. The funding and availability of quality courses tends to be inconsistent in STEM, favoring schools with more access to resources, knowledge, and expertise.

The National Science Foundation's (NSF) Rural Systemic Initiative (RSI) focused on the nation's most rural and historically impoverished areas of the U.S. RSI, running from 1994-2008, was one of the most significant federal efforts to address recognized inadequacies in STEM education in rural America.[25] The goal of RIS was to improve STEM education in these communities and develop sustainable networks on learning in each community. The Appalachian RSI (ARSI), based on testing conducted in 2000, showed that 91% of schools in the region showed improved student performance in either math or science and 62% show improvement in both.[26] The ARSI project is just one of many examples of improving STEM education in rural areas.

Fiscal year 2018 saw no change or small gains in STEM education funding, despite President Trump's sharp cuts or outright elimination of programs all together. A rural STEM education program is needed to build upon the successes of RSI. While FY18 saw slight improvements in STEM education funding, consistent and reliable STEM education funding is essential for diversifying the STEM workforce. Supporting consistent and reliable funding for STEM is necessary to meet increased workforce demands.

iii. Provide greater financial resources to minority students

Underrepresented minority students are more likely than white or Asian students to come from low-income households and be first-generation college students. [27] The financial burden disproportionally hinders students from these backgrounds to attend college. These students are also more likely to work while in school, deterring them from participating in research opportunities, many of which are unpaid.

[20] Srinivas Pentyala, James Dilger, and Mario Rebecchi, "Minority Students and STEM Careers: Will Mentoring Help?," *J Health Edu Res* 4, no. 175 (2016), https://doi.org/10.4172/2380-5439.1000175.

[21] Pentyala, Dilger, and Rebecchi.

[22] C. Pfund, "Studying the Role and Impact of Mentoring on Undergraduate Research Experiences," n.d., 1–18.

[23] "Project Exploration: Who We Are," accessed July 29, 2018, http://www.projectexploration.org/about-pe/.

[24] The United States Department of Education, "STEM 2026: A Vision for Innovation in STEM Education."

[25] The United States Department of Education.

[26] Appalachian Rural Systemic Initiative (ARSI), "Appalachian Rural Systemic Initiative: Year 7 Progress Report," n.d.

[27] Mica Estrada et al., "Improving Underrepresented Minority Student Persistence in STEM," *CBE Life Sciences Education* 15, no. 3 (2016): 1–10, https://doi.org/10.1187/cbe.16-01-0038.

Institutions that provide financial support to students will produce higher levels of student performance. While this inequity is larger than the scope of academic institutions, universities must address how the rising costs of college are affecting students from low-income families. Additionally, federal and private agencies must provide greater financial resources to low-income STEM students to reduce the economic barriers to fully engage in STEM.

VI. Conclusion

The U.S. must remain a leader in STEM in order to meet rising workforce demands. In order to produce 1 million more STEM graduates by the end of the decade, efforts are needed to prepare and inspire all students from diverse backgrounds, including women, under-represented minorities, and people with disabilities. To achieve this goal, I suggest altering paid parental leave legislation, encourage a "STEM for all" philosophy in programs, and provide greater financial resources to minority students. These actions will help level the playing field for underrepresented groups in STEM and ensure another century of American prosperity.

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