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CHCI White Paper

DEVELOPING THE NEXT GENERATION OF LATINO LEADERS®

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STEM, Shoots and Leaves:

Increasing Access of Underrepresented Groups to High-Quality, Career-Readying Science, Technology, Engineering and Mathematics Education

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What and where are the jobs?

Projections indicate that over the next decade, a gap of more than a million jobs requiring STEM skills will develop—that is, a million more workers with STEM skills will be needed than our educational system is on track to prepare (PCAST 2012). At the same time, Latino youth will show the greatest increase in college enrollment (39%) by 2017 (WHIEEH 2011). Evidence indicates that these students are less likely than average to complete post-secondary STEM degrees. This means that the "million-worker" gap may be an underestimate unless STEM education reform can improve the experience of learning science for students in general, and Latino students in particular.

Current news reports already presage this jobs gap; even as unemployment persists, certain industrial sectors proclaim that they are seeking to fill well-paying jobs, but cannot find sufficiently qualified candidates. While some level of unemployment will always be with us, narrowing the gap in many of these skilled labor sectors is feasible. It does, however, require an examination of what these "STEM-capable" jobs require, what STEM graduates and STEM-curious students lack, and what schools, employers, and governments must do to make up the difference.

The jobs gap is not at the top

An optics problem complicates the STEM jobs gap story, which is that it is a middle-skill jobs story. It is sometimes hard to conceive of a jobs gap where there is a surfeit of overqualified candidates, but the fact is that even as experienced senior scientists languish looking for work, their particular skills and salary or intellectual expectations may make them non-ideal for the jobs in question. For STEM academic faculty, who from their vantage see an overproduction of STEM PhDs who would like to join their ranks, and who since the economic downturn have seen a large spike in graduate applicants, it may seem that the pipeline is overflowing! But it is exactly the academic community's focus on this top layer that may distract from the larger workforce problem.

The middle-skill character of the jobs gap is both a curse and a blessing. The good news is that the majority of jobs currently not filled, as well as a majority of those projected in coming years, require more than a high-school diploma, but not more than a 4-year degree. Many currently underqualified job seekers may not be far away from attaining the skills they need. If the high-growth jobs in question required more advanced levels of training, the nation would face a real capacity problem; it would take several more years and more university capacity to make significant progress in producing additional MS, or PhDs. The bad news is that producing advanced degrees is what prestigious institutions of higher learning, and their funding stakeholders have traditionally focused on to the detriment of more incremental postsecondary education.

Only 5 million (about 3.5%) US jobs go to scientists and engineers with advanced degrees; most of the vaunted "STEM job" growth over the next decade will not be in the "expert" areas like university teaching or government research. At least 30% of 2018 jobs will likely require education at the level of an associate's degree or certificate.

A greater diversity of women and underrepresented minorities is still needed at expert levels, particularly in engineering, computer science, and the physical sciences. Still, the greatest need in coming years will be for bachelor's or associate's level STEM degrees. Focusing efforts to produce more STEM degree holders who are immediately career-ready at more incremental levels *will* have the subsidiary effect of increasing the pool of adults who are prepared and have the habits of mind to pursue additional STEM degrees that allow them to rise to "expert" levels in the future.

In many ways, the Latino student population serves as a "canary in a coal mine"— the challenges they face in pursuing STEM degrees highlight pervasive problems that affect all students to a

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lesser degree. In this work, we attempt to demonstrate how the current inflexibility of the traditional STEM higher education experience leads to its less-than-optimal responsiveness to the needs of its students and the economy.

What are "STEM-capable" jobs?

The employment sectors expected to see the most growth are "STEM-capable"—they require post-secondary levels of math, biology, technology, or engineering knowledge, even though the day-to-day tasks of these jobs may only rely on these skills part of the time. For example, new jobs in healthcare will require facility with electronic health records and operation of specialized biomedical equipment. Carnevale et al. (Dec. 2011), in work that analyzes salaries and demand for students with various college majors, noted that workers with BAs in healthcare have lower unemployment rates than people with graduate degrees in any other field except the life and physical sciences, indicating the rising demand in this sector. Diagnostic equipment is increasingly being designed for use by healthcare workers who are not doctors, and many new healthcare jobs will be in hospice or other residential environments, where individuals will be required to skillfully operate this equipment independently. These STEM capabilities are required *on top* of the psychologically demanding work of caring for others.

Structural changes to address the gap between education and employment over recent decades have been suggested by a number of policy analysts. Aside from policy recommendations that discuss education reform, as we do here, Sallet and Pool (2012) have called for federal agency reorganization that would create a "common application" for efforts from private trade and technology concerns to receive funding for projects in workforce development—specifically they call for the creation of a new agency that brings technological and workforce development experts into a body that combines the authority of the Department of Commerce and the Small Business Administration. This agency would have much in common with the Jobs and Innovation Accelerator Program, new in 2011 at the Economic Development Administration, which in its first year received a high number of applications that fuse cross-sector goals.

In recent decades, the outsourcing of both service and manufacturing jobs abroad has eliminated jobs and driven down wages for those that remain stateside. Fortunately, there are signs that the reports of American manufacturing's death have been at least somewhat exaggerated. However, the remaining and newly created "advanced manufacturing" jobs in the US are likely to be highly technological; for a variety of reasons including environmental restrictions, it is less likely that consumer products that only need to be shipped once to reach American customers will return to our shores (products requiring skilled assemblers are more likely to remain. White-collar service work, such as tech support or customer service, will increase in "portability" and outsourcing across great distances as worldwide access to broadband increases. For this reason, the educational bar for the desk jobs and factory jobs of the 21st century that *do* remain in the United States is being raised. Domestic employers must have an expectation of added value from American employees to offset the higher cost of doing business here at home(STEM innovativeness is one form of added value).

Agricultural work will also increasingly require STEM-capable workers. Despite popular interest in access to local or organic foods, the vast majority of produced and prepared food will necessarily continue to come from large-scale agricultural concerns. However, as public demand for food that they perceive as "fresher" or "healthier" drives business, new technology, both biological and mechanical will be necessary to develop these products and speed them to shelves. Agricultural work is one of the lowest-paid, unreliable employment sectors in the country, with seasonal work, very little opportunity for advancement and is disproportionally performed by Latinos. Workers with STEM skills would potentially have greater opportunity to advance within the industry, even if automation in the sector continues to increase, particularly in the areas of food safety and productivity, but these skills will likely need to be provided in ways that accommodate non-traditional students.

STEM and STEM-capable jobs, in addition to having larger expected growth in coming years, already pay more, (on average $14,000 additional dollars a year) than other job sectors for equivalent levels of education, and have a narrower gaps, though still persistent, between the salaries of white and Asian workers with those of other races and ethnicities, as well as between males and females (Carnevale, October 2011).

All three STEM-capable sectors described above require fundamental STEM skills but are also ready to hire graduates with a bachelor's degree or less, which means we must tailor STEM programs to confer smaller sets of more targeted skills, particularly hands-on skills, in less time.

Currently, many workers who are employed in STEM-capable jobs, particularly those in non-engineering majors, arrive in such positions after completing STEM degrees whose coursework is not particularly tailored to the tasks. While this well-rounded "liberal arts" approach to career preparation is time-honored at bachelor's level, it has more and more become the emphasis at 2-year schools as well, though it may not be as appropri-

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ate for students who want very specialized training for careers near where they are already living, working, and studying. Nevertheless, these specialized certificates or associates degrees should, when possible, allow workers to reenter institutions at a later date to pursue additional degrees. Allowing STEM degree holders to more incrementally accrue credentials on a need-to-know basis is ultimately good for the economy and for individuals, as it minimizes excess course demand that is not relevant; but more work must be done to build connections and validate that courses can serve dual purposes of career preparation as well as fundamental knowledge-building that will be necessary for future schooling.

Changing the undergraduate STEM experience

Numerous expert task forces have generated or aggregated promising ideas for reforming the post-secondary STEM experience. In some cases these ideas reach backwards to tie K–12 schools and their curricula more tightly to what student are asked to do next. The President's Council of Economic Advisors (PCAST) has suggested that much of the expected STEM jobs gap could be filled by retaining students who are graduate high school interested in STEM, and are well-prepared for college, but nevertheless are attracted to other majors in their first years of school (PCAST 2012). Unlike the "pull" described by Carnevale in his analysis, where individuals with STEM skills are eventually attracted to jobs that only involve STEM-related tasks part of the time but pay better than more "pure" STEM careers, this undergraduate drain of STEM-interested students to other majors is more pernicious because students leave *before* they have STEM skills in hand. Well-prepared students with varied interests could indeed go on to fill the partial-STEM jobs Carnevale describes, but only if they gain STEM mastery in college.

The council's recommendation to retain these students noted that in the other majors that woo potential STEM students, course work more closely presages their future day-to-day tasks, with more projects, group work, internships or communication skill-building. While remaining true to itself in skill conferral, undergraduate coursework in STEM must come to more closely resemble real scientific labor and discovery. Less reliance on lectures or labs that leave no room for self-discovery of scientific principles is more attractive to students, improves their mastery and retention of concepts, and is better training for the future (although students, like instructors, may initially balk at the time required to adjust to new classroom practices). More responsive group work and experimentation will stimulate high achievers from all backgrounds, but has also been shown to improve outcomes for students who are less well-prepared (Deslauriers, 2011), because a deconstructed classroom allows for more parallel discovery, success and questioning between peers than one in which questions and answers happen only between instructor and the student who wins the hand-raising race.

Looking beyond high achievers

Retaining those who are understimulated but well-prepared is only one of several problems. More than half of all students who enroll in higher education have no degree eight years later; the degree completion rate has been in decline as more and more students choose college, especially because much of the increased capacity has occurred at less competitive institutions (Bound 2009). While student high school achievement is a predictor of degree attainment, Bound et al. found that the type of institution and its resources was a more important factor in student completion than their individual characteristics. The Gates Foundation's "Completion by Design" is just one effort improve institutional supports to improve completion rates.

Hispanic Serving Institutions are those where more than a quarter of full-time students are Hispanic. Unlike HBCUs, they are not necessarily Hispanic Serving by design, and a school's status can change over time--Whittier College in California, for example, has only recently become an HSI. Together with Tribal Colleges and Universities, and institutions that serve large proportions of Asian-American and Pacific Islanders, these schools span a wide range of locations, size, and degree offerings, including a large percentage of 2-year institutions. Reports vary in whether and why these Minority Serving Institutions serve their students better than predominantly white institutions of higher education, and success in conferring different degrees and disciplines varies widely. However, at the very least, the label at least serves to identify schools where statistically significant numbers of students from groups underrepresented in STEM are enrolled. This makes them suitable "test kitchens" where comparisons between curricular and institutional practices and student responses to them can be made scientifically. Dowd et al. have created "equity indicators" that allow them to identify Hispanic Serving Institutions whose percentage of Hispanic STEM graduates matches or exceeds initial Hispanic enrollment in STEM (Dowd 2009). These indicators enable future studies to identify promising practices at these schools and potentially adapt and scale them up elsewhere.

Hispanic trends in educational achievement are complicated by the fact that multiple generations of immigrants are subsumed in the label, making it difficult

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to separate out the effect of foreign educational or language barriers (which affect many groups of immigrants) that result from recent arrivals. However, most Latino youth are now native-born. Therefore, lack of college preparedness, even for Latino students, should be remediated by targeting the schools and curricula that serve these students in their K–12 years, rather than by blaming student country of origin or setbacks due to lack of fluency. It is notable that a recent Migration Policy Institute study (Batalova 2011) marked second-generation immigrant Latina enrollment as on par with third generation white female enrollment (46%, ages 19-24). However, there was a large gap in completion of associates degrees by age 26 by these two groups (33 vs. 55%).

Four-year degrees and transfer for STEM students

Successful transfer into and degree completion from a 2- to a 4-year school relies on a number of factors — the existence of an articulation agreement between the schools, the academic preparedness of the transfer student, and his or her ability to transition into and navigate an often very different campus and classroom environments. Bensimon et al. argue that compared with the K–12 system, there are very few "practitioners and researchers of postsecondary student success," though examples like University of Arizona/Pima County Community College's Future-bound effectively minimize transfer shock for women in STEM (Reyes 2011). Post-secondary instructors may have little to no professional development experience with pedagogical techniques or mentoring habits that support students, while post-secondary student-support staff may not have as much involvement in academic matters as other life issues (not the case with K–12 counselors). Less well-funded 2-year schools are less likely to have the funds to hire such practitioners of student success, even as they serve higher concentrations of "non-traditional" students and are therefore most in need.

The Department of Labor's Trade Adjustment Assistance Community College and Career Training Initiative could be funded to support more transitioning students, whether seeking employment or school transfer, through its mission to build links between 2-year institutions and local industry and 4-year schools. Specifically, the program benefits STEM students by providing exposure and access to large-scale equipment, research and technology that 2-year schools can rarely invest in alone.

Community colleges — strengths and challenges

Because they are geographically well-dispersed, have a history of working with local businesses and non-traditional students, are more likely to have small classes than larger higher-education institutions, and serve a majority of American post-secondary students at some point in their career, community colleges are in many ways, well positioned to be hubs for STEM-capable degrees. Forty-four percent of all STEM degree holders attended some community college, and women scientists and engineers are more likely to have attended a community college than their male counterparts, as are Hispanics and Native Americans, indicating that strengthening these schools might diversify the STEM workforce more quickly (Jackson 2011). In addition, nearly 40 % of K–12 teachers began in community college giving all the more reason to strengthen these programs (Barnett 2006). Education majors are among those who are most assured of finding and persisting in a job in their field (Carnevale 2011), so there is real value in directly enhancing the STEM exposure of those who will go on to influence future generations of students, regardless of the subjects they teach.

Unfortunately, community colleges face large challenges in offering cutting edge teaching in STEM disciplines. Enrollment growth over the past few years has been higher at community colleges, while state allocations for public higher education have stagnated or dropped (Nettles & Millett, 2008). While smaller class sizes create nurturing environments for students, community colleges have the highest teaching loads and no graduate programs or students to lend the teaching or research assistance that is crucial to the solvency of large research institutions (Ceida 2009).

The American Institutes for Research estimates that four billion dollars are spent each year on first-year community college students who drop out (Schneider 2011). A large source of discouragement is placement in a remedial math or writing course. Community college students are more likely to require remedial math coursework (almost 60%) than students at more competitive 4-year schools (25%). These courses absorb school classroom and instructor resources, but are not usually credit-bearing, so even the best case scenario, where the student completes a remedial course the first time, still leaves him or her a semester behind in STEM major tracks, despite all of the school and student's effort. What is worse, failing such a remedial course is correlated with a higher chance of never completing a degree. Fortunately, recent studies into interventions such as summer catch-up courses, or even more informal emphasis and encouragement of incoming students to treat incoming placement exams as high-stakes tests worth preparing for, have shown that a significant portion of

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students currently taking these courses might, with just a little help, review their high-school learning and instead, enter ready for new, rather than unnecessary remedial coursework. These interventions are also important for 4-year schools, where the cost per credit, even for remedial courses, is typically much higher.

Creating STEM-minded students

Compared to other disciplines, research experiences in STEM fields can be expensive for schools to offer and appear competitive and inflexible to students and their schedules. The more hands-on training a student receives in their discipline, the better prepared they will be. However, STEM lessons and activities can be hands-on without being thought-provoking, which is why many calls for reform argue for increasing student access to "authentic research experiences," e.g. open-ended projects that are appropriate for students but still give them truly unanswered scientific questions to try to solve.

While most schools have adopted the traditional lab coursework as a matter of scale, limited resources and a desire for modularity, this coursework is as unlikely to attract and develop curious problem-solvers to science or engineering research as paint-by-numbers would attract and develop young artists to painting. Controlled studies have now shown that various student research experiences lead to higher grades, greater persistence in and shorter time to STEM degrees, and greater interest in post-graduate education (PCAST 2012). It is crucial that students who will begin their careers as middle-skilled workers gain exposure to the physical setting and collaborative environment of technical workplaces, including informed attitudes to safety and risk management that are difficult to internalize when presented in a lecture, discussion, or a controlled, "cookbook"-style lab course.

Classroom, department, and institutional policies that require students to "opt-out" of interventions can "nudge" them to participate more in structures or programs that improve student success. Requiring attendance, contacting students who don't attend or fail exams early, and providing students with near-real-time data about how they are doing compared to their classmates can give them context and prevent surprises or disappointment. At the institutional level, schools can reach out to students who are close to graduation but, for whatever reason, have dropped out. This is one of the easiest ways to make good on the investment – by the public with education funds, and the student with their time, money and effort already made.

Socioeconomic barriers outside of STEM higher education reform

On average, and particularly in the physical science, computer and engineering fields, colleges and universities do not prepare minority and female students as well as they do white and Asian students. However, it is important to analyze the early infrastructural reasons behind this, as well as the cultural or sociological factors. Research from the American Council on Education has noted several key differences between students (ostensibly from the class of 2001) who completed their STEM bachelor's degrees within six years and those that did not, and their findings suggest ways that educators and departments might build flexibility that benefits a larger set of students (CUGESEWP, 2011). Students who had not graduated were less likely to have taken rigorous high school courses, less likely to have entered college at age 18, more likely to have grown up in a low-income household, more likely to work more than 15 hours a week, and less likely to have parents who had, themselves, graduated from college.

Reardon recently demonstrated that the achievement (K–12 graduation) gap between rich and poor Americans now dwarfs the white-black achievement gap (which itself is larger, in general than that between whites and Hispanics). The opposite was true for much of the post-WWII era. While the white-black gap persists, it was, in 1960, one and a half times the 90^{th}-10^{th} percentile income gap; today it is only half as large (Reardon, 2011). Unlike documented ethnic achievement gaps that grow as students do, this income-based achievement gap appears to hold relatively steady from kindergarten on. Another frequently cited achievement gap, which correlates student performance with parental education, used to be one of the clearest influences, but today, parental *income* is nearly as strong an indicator.

Reardon indicates that this change is in part due to greater equality between race and ethnic groups since the 1960s, but also due to greater income difference between the 90^{th} and 10^{th} percentile since then, including greater institutional knowledge and spending on education by wealthier parents, greater income segregation among couples, and greater geographic income segregation, which dictates the public school and community resources at parents' disposal more than ever. This lack of resources has effects later in educational life: in a study of 5,000 Los Angeles Latino community college students, less than 9% were eligible to transfer after 3 years, far lower than average (Hagedorn, 2006).

Parental income and education levels correlate with a range of knowledge and practices that have important effects on children across their lifetime. In addition to disparate financial practices such as college savings planning or private school and tutoring investments, the National Center for Education Statistics has re-

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ported that white and Asian parents are more likely to read to their children daily than parents from other racial or ethnic groups, and there is also a correlation between parental reading-aloud habits and income. Supplementary learning support like this can help to explain why each summer vacation results in a loss of about two months of literacy for low-income students, but not for more students from wealthier families. Interestingly, the equivalent summertime loss of math skills affects students more broadly, pointing to the overall lesser presence of math at home (CUGESEWP, 2011).

This is an ugly truth for those scientists who hold a logical, meritocratic image of science in their head—the notion that a good scientist will succeed regardless of his or her background because this success does not rely on subjective interpersonal or business negotiations that can be tainted by human prejudice. A recent study of the NIH grant award process, has highlighted the fact that indeed, the infrastructure of science is just as subject to implicit bias; African-American researchers were over-represented in population of applicants whose work was rejected, and were less likely to reapply for funding, even though this reject-and-reapply process is recognized by seasoned researchers as a viable strategy for winning funding. These researchers often work at Minority Serving Institutions that lack the shared resources (equipment, support staff, collaborator network, institutional knowledge, etc.) enjoyed by colleagues at elite institutions. This lack of capacity inhibits the ability of these researchers to give their students a high quality education.

Current efforts by the Department of Education to make real college costs more transparent and discoverable online by requiring a "Net Price Calculator" for prospective students and parents will help all students with their college planning process. It is likely that students who previously lacked the resources to locate this information on their own, or who are more likely not to to postpone or forgo enrollment due to a perceived lack of affordability will be helped most. In particular, it will make students more able to weigh cost against competitiveness for the schools where they have been accepted.

The ability to make an informed decision when finally choosing a school is crucial; in an increasingly wide field of schools and programs, this "smart disclosure" of college costs and graduation rates enables first-time college students and parents with institutional knowledge (often lacking at high schools and college advising centers that serve low-income students) that will help them select a school more likely to help them graduate on time and on budget. Studies comparing outcomes for equally qualified students who attend less selective and more selective universities show that attending the more competitive school is the better move. But while only 27% percent of students in the top income quartile "undermatch" (or choose a school whose average students are less scholastically qualified than they are) undermatching happens to 59% of students from the bottom income quartile (Bowen, 2009). For students whose parents do or do not have college degrees, the rates of undermatching are 41% v. 64%. In addition, as more detailed data by academic discipline is brought to these online tools, it is likely that they may nudge STEM departments to more closely examine how well they serve their undergraduate students, not just their graduate and faculty researchers.

Culture change for academics

More than other disciplines, STEM fields have a reputation for "weeding out" incoming students who don't, on their own, meet some standard of competence (rather than for building this competence); overtime, a pervasive perception that students must come to STEM subjects with innate ability or perseverance if they expect to survive has developed (Dowd, Dec. 2011). It is curious that practitioners of science and math who value self-discovery and corroboration of evidence so rarely create an environment for their students to experience either. It is hard to imagine such a "gatekeeper" reputation in other purportedly creative fields. While there of course must be high standards for the future surgeons, architectural engineers, and cybersecurity professionals who need fundamental STEM skills, there is no reason to withhold problem-solving, team-building, inquiry-based learning until students have first run a semesters-long gauntlet of 500-student introductory lecture courses where they have little interaction with their professor, classmates, or frontier research problems of the field.

Most STEM faculty primarily use traditional teaching methods. Investing time into reading and internalizing educational research is a luxury that many of them do not have time to take advantage of; many younger, untenured faculty who may have an interest in teaching using evidence-based methods find that they will not be rewarded by their departments for devoting time to teaching, even if they demonstrate improved outcomes for students. One top-down solution for higher education administration to apply to this problem is to increase access to and visibility of evidence-based coursework already going on, and to reward those faculty for their enhanced service to students, whether through funding awards or institutionalized recognition of their practices that counts in tenure decisions.

Perhaps more difficult than altering first laboratory or field experiences will be changing the traditional ways that STEM faculty communicate fundamental princi-

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ples outside this space, particularly as higher education budgets are tight and less experienced non-tenured/adjunct faculty become a larger part of the higher education teaching workforce. It will take time for STEM faculty to learn how to successfully use classroom and web 2.0 technology, and more student-centered classroom tasks, to enhance learning and retention of scientific concepts. Quite often, while these methods boost student mastery across the board, they improve outcomes for students from underrepresented groups, including women, African-American and Hispanic students more than average (PCAST 2012).

There is some evidence that educators who teach non-majors courses are already more flexible in their teaching methods; only two-thirds of arithmetic courses used alternatives to lectures, while anywhere from four-fifths to nine-tenths of calculus and differential equations courses did (Bragg, 2011). Programs like CRAFTY (College Renwal Across the First Two Years) and Quantway and Statway are building curricula and tools to disseminate more non-traditional practices and more integrative, problems-based topics widely.

Greater access to hands-on courses may help to recapture students with spatial reasoning strengths that in the past gravitated towards manufacturing or trade school, but may no longer have access to such specialized technical courses in high school, or know how these interests connect to technological careers that sound highly specialized or unfamiliar (CEHR, 2010). Integration of engineering concepts and tasks early on in K–12 could entice new students. Students may also benefit from teachers who have experience in industry or otherwise know how to recognize potential in students who may not have excelled or delighted in traditional curriculum up to that point.

Black and Hispanics made up only 7% of K–12 teachers, combined, in 2008, and students who are Black or Hispanic are less likely to have teachers who "look like them" and less likely to have experienced STEM teachers with STEM degrees, because they are more likely to attend high-poverty schools, whose teachers have higher turnover and less seniority. Programs that recruit broader student populations to teaching degrees, especially programs that allow concurrent pursuit of STEM degrees in a timely fashion, can improve these statistics, as can proposed legislation that requires "comparability" in access to high-quality teaching at the school, rather than district level.

Latino focus

Latinos have the lowest educational attainment level of any group in the US, and only about 50% of Latino students complete high school on time. These low numbers are in part due to recent immigrants of school age, who face special challenges to graduation, such as a need to contribute financially to their family, a language barrier, and mismatch with previous schooling. However, even full-time, native born Hispanic students have relatively poor student outcomes and lower access to challenging, college-ready coursework taught by teachers with content expertise, particularly STEM expertise in their K–12 education, which limits their choices when it comes to college.

Nevertheless, there has been tremendous growth in degree attainment for Latinos in the past few decades: a 64% increase in non-STEM degrees from 1998 to 2007, and a 50% increase in STEM (Dowd, 2010). Increases are much lower in the "hard" (natural, physical, or computer) sciences, math, and engineering. This individual non-STEM/STEM gap is recapitulated in degrees awarded by Hispanic Serving Institutions: 40% of all Latino bachelor's degrees are awarded by HSIs, but these schools award only 20% of STEM bachelor's degrees, which is to say that HSIs do a relatively worse job in retaining their Latino students in STEM majors than other majors. It may be that some of the interventions and experiences that motivate students to complete STEM degrees are out of the reach of these schools due to lack of resources or expertise, so building research and teaching capacity in the STEM departments of these schools may improve these figures.

Interestingly, African-American and Hispanic students, who are sorely underrepresented in all STEM fields other than the social sciences, express interest in these fields at comparable, if not higher rates as White and Asian students. Data from the UCLA Higher Education Research Institute show that 36% of Latino freshmen at 4-year schools indicate an intention to major in a STEM field, and in fact, this level of group interest dates to the 1980s (CUGESEWP, 2011). Some studies have also found that African-American and Hispanic students self-report greater engagement in their college experience than their peers, including greater personal, social, and academic gain at both 4- and 2-year schools (Greene and McClenney 2008). For minority students, college may offer more opportunities for engagement than high schools, and they may be more eager to take advantage. Institutionalizing "student success" courses for credit could reward these students for their efforts and personal progress. Hands-on coursework, internships, and the like may help these students because the environment they invest energy acclimatizing to is a real-world job environment (which older students or those with work experience may actually be more comfortable in), rather than a temporary educational space. Project-based lab work lends itself to a learning community model that has shown some success in preventing student attrition.

While there will always be the rare individual who will rise to the top without benefit of formal education and training, he is the exception and even he might make a more notable contribution if he had the benefit of the best education we have to offer.

Vannevar Bush — Science, The Endless Frontier

Routes to Advanced Degrees

As discussed in the introduction, there is overall, no shortage of STEM PhDs. However, women and minority groups are underrepresented to various degrees at these educational levels. Therefore, it is worth considering factors that dissuade students with high interest and preparedness from seeking advanced STEM degrees.

People are motivated by a number of values in their search for a career that is "right" for them. Even if students engage with material, they may take away (inaccurate) lessons from their STEM professors about what work in a STEM-capable field will be like. For example, Carnevale concluded that full-time academic research chemists are motivated by values of achievement, independence, and recognition, from a long list of options; this set of professional motivations is relatively rare. Often, the argument is made that minority students need to see professionals who "look" like them, but Carnevale's research, as well as other findings about the effectiveness of mentors to empower students across ethnic and gender lines, gives credence to the notion that they also need to interact with STEM professionals who, instead, share their values. This is good news when one considers that there are hardly enough female or minority mentors to usher the next generation of STEM workers, unless they set aside their own personal career and research goals! If newly minted STEM grads are not satisfied by the types of rewards typically afforded by a focused STEM career, a 100% STEM job may not be a good career choice, even if the student is qualified. Exposure to professionals through internships, mentorships, or speakers' series, can provide students with alternative visions of their STEM-capable future, and prevent self-selection out of STEM environments where the academic culture is not inviting (Wai-Ling Packard, 2011).

Students from low-income backgrounds may still be expected or feel compelled to contribute financially to their families even after they are technically independent adults, even after completing their associate or bachelors' degree. Even if not, the desire to stay out of debt motivates student populations differently. Hispanic STEM bachelor's degree holders were more severely deterred by their student loan debt than other students (Dowd 2011). While it is unreasonable to suggest that graduate stipends, across the board, should compete with salaried jobs in terms of dollars, schools *can* combat the risk aversion of underrepresented students by guaranteeing placement as a teaching or research assistant during graduate school, offering at least the consistency of "a real job." Highlighting the recent extension of income-based repayment of student loans more broadly to careers in public service, including STEM-capable public service, could also lessen the fear that investing in higher STEM education doesn't pay.

Conclusions

Increasing the number of students who complete STEM certificates, associates, bachelor's and master's degrees—particularly Latinos and other groups who are currently underserved by the educational system—is necessary both for filling the anticipated open jobs of the near future, and for developing the industrial technologies, computing hardware and applications, health therapies, environmental stewardship and frontier scientific questions of the coming decades. It is more than just a matter of filling existing desk chairs and assembly line posts. Scientific innovation is often the driver of brand-new job creation, including local support jobs that do not require STEM skills. America is regarded, even by nations whose growth in research and industry now outpaces ours, as a place where scientific and technological creativity flourishes. Cultivating scientific curiosity and industriousness in more of our students, and connecting it to meaningful work that serves the greater public, is essential to preserving our health, prosperity and commitment to opportunity for all.

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