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Tapping Underserved Students to Reshape the Biomedical Workforce

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Abstract

Low-income and underrepresented minority students remain a largely untapped source of new professionals that are increasingly needed to diversify and strengthen the biomedical workforce. Precollege enrichment programs offer a promising strategy to stop the "leak" in the biomedical pipeline. However, in the era of highly competitive science education funding, there is a lack of consensus about the elements that predict the long-term viability of such programs. In this commentary, the authors review the critical elements that contribute to the long-term viability of university-based precollege biomedical pipeline programs. Successful programs are built on a foundation of responding to local community workforce needs, have access to local universities that provide an organizational home, and offer a direct pipeline to strong undergraduate science training and support for graduate or professional training. Such programs have shown that there are substantial pools of diverse students who can thrive academically when given enrichment opportunities. Replication of pipeline programs with long-term viability will be instrumental in reaching the large numbers of talented underserved students who are needed to diversify and strengthen the biomedical workforce over the coming decades.

Keywords: Career choice; Education; Minority groups; Science

Introduction

One of the most pressing issues facing today's biomedical pipeline is the underrepresentation of low-income and minority students. While these students are critically needed to meet workforce demands [1], they continue to have worsening educational outcomes exacerbated by poor performance in science and math, the gateway subjects to biomedical careers [2]. For example, Hispanics, the fastest growing demographic group in the US, make up 16 percent of the population, but only 2.4 percent of the academic "pipeline" in science, technology, engineering, and mathematics (STEM) disciplines [3]. Of the 3 million students who enter US colleges every year intending to major in a STEM field, less than half graduate with a STEM degree, with even lower rates among underrepresented minority (URM) students [4,5]. As a result, educators are calling for major improvements in broadening the science pipeline to include greater numbers of low-income and URM students. Without such improvements, a deficit of one million college graduates in STEM fields is predicted over the next decade [4].

A key step in addressing the deficiency of low-income and URM students in biomedical fields is to intervene before college to nurture their interest in the sciences, ensure their successful transition into college, and improve their persistence in science-related disciplines [6]. High school academic enrichment programs on university campuses offer one promising strategy to help stop the "leak" in the biomedical pipeline [7]. These programs reach out to youth at a time when they are particularly vulnerable for falling off a successful science trajectory [2]. Programs hosted at universities have the capacity to immerse underserved students in the college campus experience, link them with state-of-the-art educational and technological resources, provide social and mental health support, and build connections with university faculty, staff, and students who serve as role models and mentors. By providing in-depth experiential learning, they create a sense of belonging and stimulate academic achievement, communication skills, and leadership qualities that can boost the students' retention and long-term success as they apply to and enter college [8]. Programs with residential components have the added benefit of reaching students from diverse geographic areas including isolated rural towns.

Interestingly, only a small proportion of federal funding for low-income and URM students in the sciences is allocated to precollege programs [9]. Even established sources of federal funding for precollege programs have faced uncertainties. Funding was only recently reinstated for the Science Education Partnership Awards (SEPA; www.nihsepa.org), which have enabled hundreds of programs to reach deserving students in their precollege years and prepare them for success in biomedical careers. Furthermore, few precollege programs are sustained on a long-term basis, even those that have effectively demonstrated enhancement of student interest, retention in the sciences, and high college matriculation and completion rates. A challenge to their sustainability is their frequent reliance on individual faculty and grants rather than institutional or donor support, especially in the current era of highly competitive science education funding.

One of the most established university-based SEPA-funded programs is the Stanford Medical Youth Science Program (SMYSP; http://smysp.stanford.edu) [8,10]. For 26 years, this program has partnered with Northern California high schools to link very low-income, predominantly URM students with the science-rich resources of Stanford University and its surrounding community. Approximately 300 students submit detailed applications annually, from which 24 students are accepted into a 5-week Summer Residential Program, with all costs paid. Preference is given to

students who come from highly disadvantaged circumstances (e.g., poor academic preparation, foster care, or agricultural labor camps). The program focuses on inquiry-based and experiential science learning, hospital internships, independent research projects, personalized coaching from Stanford peer mentors, college admissions preparation, and long-term career guidance. In the process, it cultivates a sense of social belonging, self-efficacy, and perseverance toward achievement of academic and career goals. In 2011, SMYSP received the US Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring, the highest honor bestowed by the US government for mentoring in these fields.

Long-term educational outcomes of the 618 SMYSP alumni to date have been extremely positive: 99% have gone to college (compared to a California statewide average of 61.7%) [11], and those who were no longer in high school or college have earned a 4-year college degree (90%). Among those who have completed college, 47% are either attending or have completed graduate or medical school, and 44% have entered biomedical careers. One can be greatly encouraged by the large numbers of high-potential students who apply to SMYSP annually, evidence of the substantial pools of diverse students who can thrive academically when given the opportunity to participate in biomedical enrichment programs.

The longer-term sustainability of SMYSP was recently enhanced by its move to a new organizational home within Stanford Pre-Collegiate Studies, thus reducing its dependence on its faculty founder and grant support. In addition to a partial endowment of ~1 million dollars from private donors, it received 5-year transitional funding from the School of Medicine and University Provost Office. These transitional funds are supplemented by several new income-generating science-focused programs that provide additional funding for SMYSP.

The elements that predict long-term viability of university-based precollege biomedical enrichment programs such as SMYSP are rarely discussed. Based on experiences from 26 years of directing SMYSP, we believe that programs that encompass a strong pipeline approach are the most viable. Such programs are built on a foundation of responding to the workforce needs of the local community. They intervene early to enhance college admission rates in the sciences, have access to affordable local universities that are strong in undergraduate science training, and provide support for graduate and professional training for those seeking to enter biomedical careers. Critical to program sustainability are strong partnerships between local organizations (e.g., schools and community-based organizations) and universities that are committed to ethnic and income diversity along all stages of the educational pipeline [6]. Key elements that we believe enhance the viability of university-based precollege biomedical enrichment programs are summarized in Table 1.

Key element	Components for viability
Sustainability plan	Plans are incorporated from the inception of the program for long-term sustainability, including how to ensure stable and adequate funding.
Local biomedical workforce needs	The precollege program responds to local community workforce needs for biomedical professionals.
Host undergraduate university	An undergraduate university with strong STEM resources, infrastructure, and community engagement hosts the program and provides a well-suited long-term organizational home.
Pipeline to science-rich university	As students matriculate into college, an undergraduate university (either the host university or others in proximity) with strong STEM majors provides a direct pipeline for academically competitive students and offers academic support and financial aid.
Graduate and professional biomedical training	When students complete undergraduate training, universities are accessible that offer graduate and professional biomedical degrees with supportive academic environments, career guidance, and financial aid.
Local workforce commitment	The local workforce makes a commitment to biomedical job development, outreach, and hiring of diverse applicants.

Table 1: Key elements for successful university-based precollege biomedical pipeline programs.

SMYSP meets most of these criteria. Students who attend SMYSP live in Northern California, an environment with a critical need and ample jobs for those educated in biomedical disciplines. Stanford University has a large established precollege infrastructure that provides the long-term organizational home for SMYSP. Although Stanford is not a direct pipeline for most SMYSP graduates (9.8% attend Stanford), students are highly competitive for the ten University of California (UC) campuses that provide high-quality, affordable college education for California residents. The majority of SMYSP students (53%) graduate from a UC, and 90% of those graduate from one of the four UC schools known for their strengths in science and technology (UC Berkeley, UCLA, UC San Diego, and UC Davis). Many SMYSP graduates also continue on to a UC graduate or professional school.

After low-income and URM students have matriculated into college, adequate support and resources are essential to sustain their academic trajectory and retention in STEM majors. Key areas of support include academic resources for mastering difficult science courses, research opportunities, mentoring and personalized advising, study abroad opportunities, internships, employment and teaching opportunities, and financial aid. A number of universities and community colleges offer these resources. The University of Maryland Meyerhoff Scholars Program, established in 1988 and now with more than 900 alumni, is recognized as a national model that leverages resources at a research-intensive institution to increase diversity in STEM fields [12]. The City University of New York's multifaceted initiative to improve college retention among URM students is another model program that achieved a more than doubling of graduation rates (from 23% up to 56%) [13].

Broader implementation of precollege biomedical pipeline programs with long-term viability such as SMYSP can be instrumental in meeting the federal mandate to identify and replicate effective

interventions to enhance the nation's global competitiveness [14]. With increased investment by the National Institutes of Health, National Science Foundation, and other federal agencies, we can reach thousands of talented underserved students who will diversify and strengthen the biomedical workforce. Precollege programs can nurture and reinforce their interest in the sciences through enrichment opportunities. College programs can sustain their successful academic trajectory and retention in STEM majors. These programs are worthy long-term investments, as low-income and URM students who become biomedical professionals often connect their educations with careers in underserved communities, become advocates for those communities, and are role models for younger people who will be needed to expand the biomedical workforce over the coming decades.

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