CLOSING THE LEAK: KEEPING LATE-DECIDING STUDENTS IN THE PIPELINE TO BIOMEDICAL RESEARCH CAREERS

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Abstract

With the increased competitiveness of undergraduate, graduate, and professional programs, the continuously accelerating rate of technological innovation and development of new global means of communication, and the evolving face of the local, national, and global job markets, choosing a long-term career has become a challenge for many. More and more students opt to take a gap period in their education, pre- or post-college, for soul searching to determine their future path or for improving their skills and competitiveness for successfully applying to academic institutions. Even though such gap years can lead to more mature and determined students, they often derail the educational path of the individual by leading to loss of interest or to new commitments which hinder going back to school. Engaging students in academic and skills training programs that keep them within the academic environment and provide them with exposure to the benefits of higher education has been shown to increase their persistence, leading to an increased rate of attaining higher-level degrees.

A number of United States (US) federal funding agencies, including the National Institutes of Health (NIH), have programs such as the Bridges to Baccalaureate Program (support for easing a student’s transition from a 2-year junior or community college to a 4-year baccalaureate-granting institution) and Post-baccalaureate Research Education Program (PREP, support for recent college graduates from underrepresented groups or disadvantaged backgrounds to strengthen their research skills and academic competitiveness for pursuing a doctorate degree in the Biomedical Sciences). At Xavier University of Louisiana (Xavier), we have developed a post-baccalaureate technician program under Project Pathways (the NIH National Institute of General Medical Sciences (NIGMS) Division of Training, Workforce Development, and Diversity (TWD)-funded Building Infrastructure Leading to Diversity (BUILD) Program), that provides research experience and training in soft skills to recent Xavier graduates to increase their preparation and competitiveness for graduate programs. The BUILD Technicians also receive both mentee and mentor training and serve as near-peer mentors to undergraduate students in their labs, increasing their scientific identity and preparing them for their future role as graduate teaching assistants. Here, we report the lessons learned from this program and how its differences from other post-baccalaureate programs, including those under the NIH PREP umbrella, have led to improved outcomes for Xavier graduates gaining admission to graduate programs in the Biomedical Sciences.

Keywords: Post-baccalaureate, research training, diversity.

1 INTRODUCTION

Xavier University of Louisiana (Xavier) is a historically Black and Catholic university that is widely recognized in the US for its Science, Technology, Engineering, and Mathematics (STEM) curricula. In the Fall 2018 Semester, approximately 72% of Xavier students were African American, and approximately 79% of its undergraduate students majored in the Biomedical Sciences (Biochemistry, Bioinformatics, Biology, Chemistry, Computer Science, Data Science, Mathematics, Neuroscience, Physics, Psychology, Public Health Sciences, and Sociology) [1].

Based on the number of African American students who earn bachelor’s degrees in the US, Xavier ranks second in the Physical Sciences and fourth in the Biological and Biomedical Sciences [2]. According to a 2013 US National Science Foundation (NSF) report providing data on the number of African Americans earning doctorate degrees, Xavier ranked first in the Life Sciences, fifth in Science and Engineering, and seventh in the Physical Sciences [3]. According to the 2012 report on Diversity in Medical Education published by the Association of American Medical Colleges (AAMC), Xavier ranked first in the number of African American alumni who completed their medical studies successfully; December 2018 AAMC data continues to confirm this ranking [4]. The success of Xavier’s Pre-Medical program was also highlighted in The New York Times [5].

The percentage of individuals from underrepresented groups (Blacks/African Americans,
Hispanics/Latinos, Native Hawaiians/other Pacific Islanders, American Indians, and Alaska Natives) who obtain doctoral degrees in Sciences is still lower than their total percentage in the US population, even though some progress has been made in recent years [6,7]. According to the US Census Bureau, these groups formed 39.3% of the US population in 2017; however, according to the “2017 Women, Minorities, and Persons with Disabilities in Science and Engineering Report” published by the NSF, National Center for Science and Engineering Statistics, they made up only 30.5% of the doctoral degree recipients in all fields; 31.6% in the Life Sciences; 24.0% in the Physical and Earth Sciences; 32.4% in Mathematics and Computer Science; 35% in Engineering; and 30.7% in the Psychological and Social Sciences [6,7]. These sources show that, for Blacks/African Americans, there is a much more significant disparity between their percentage in the US population (13.4%) and their percentage obtaining doctoral degrees (in all fields (6.7%), Life Sciences (6.5%), Physical and Earth Sciences (2.5%), Mathematics and Computer Science (2.8%), Engineering (3.9%) and Psychological and Social Sciences (7.7%)) [6,7]. Affirming the importance of Historically Black Colleges and Universities (HBCUs) in the progress toward eliminating this disparity, approximately 30% of Black/African American PhD recipients are reported to have earned their undergraduate degrees from HBCUs such as Xavier [7]. Nation-wide efforts and initiatives are required to increase the number of individuals from underrepresented groups who pursue and successfully complete graduate degrees.

Even with Xavier’s success in preparing its students, some with great potential for graduate studies and research careers still graduate without specific plans for continuing their education. Due to Xavier’s national reputation in Pre-Medicine and Pre-Pharmacy, the majority of its Science majors come to Xavier with plans for pursuing careers in those areas. Such careers are familiar and socially associated with prestige, financial success, and job security. In addition, students and their families often lack familiarity with other scientific careers and opportunities available to them. Students who change career goals late in their undergraduate years, ‘late-deciding students’, lack sufficient time for preparation and planning for graduate school, and thus often lack confidence in their scientific abilities. Such students are reluctant to apply for post-baccalaureate, master’s, or doctoral programs at other institutions, especially those at research-intensive universities. When not retained in an academic setting, these students are less likely to seek further training and education. In our informal post-graduation follow-up communications with many Xavier students who have taken non-academic gap years for various reasons, including financial ones, we have found that they tend to become settled into what they thought would be a short-term, full-time job, and are more likely to fall out of the pipeline. Gaining soft-skills and hands-on research training by performing full-time research in a supportive academic environment significantly increases these students’ preparedness and competitiveness for continuing education and remaining research active.

Project Pathways is one of only ten BUILD programs funded by the NIH-NIGMS with the overarching goal of diversifying the biomedical research workforce by increasing the number of students from underrepresented groups who enter and successfully complete graduate programs with terminal degrees. Project Pathways is designed as a holistic, integrated, and coordinated program across the biomedical academic departments, student academic and career support offices, and the University’s faculty development center. The Program provides mechanisms and safeguards to ensure that coordination and integration occur at all levels.

The overall hypothesis of Project Pathways is that when individuals from groups underrepresented in scientific research careers are provided with a) early awareness and deepening exposure to biomedical careers; b) supportive relationships as they move through the pathway; c) suitable infrastructure; and d) meaningful engagement in biomedical research experiences and adequate research resources, a higher number will succeed in entering and successfully completing graduate programs, leading to increased diversity in the biomedical research workforce.

The Post-baccalaureate Technician Program (PTP) under Project Pathways provides recent Xavier graduates from the biomedical disciplines with the opportunity for mentored research and soft skills training to prepare for successful application to and completion of graduate programs [8]. This initiative provides post-baccalaureate training at the students’ undergraduate institution, a critical aspect, since many of the target students are not confident in their scientific abilities, not competitive for, and/or otherwise reluctant to apply for post-baccalaureate or graduate programs at the time of their graduation. Prior to BUILD funding, a number of Xavier faculty used their individual research grant funding to hire Xavier graduates as research technicians. As Xavier does not have graduate programs in most of the biomedical departments, these arrangements significantly increased the faculty members’ research productivity, while also leading to the placement of most of these technicians in graduate programs. The positive outcomes of this model were used in designing the PTP, which in
addition to the hands-on research training also provides some necessary soft skills training. These training opportunities include mentor and mentee training, cultural responsiveness training, and responsible conduct in research (RCR) and ethics training. The Technicians also serve as near-peer mentors to the undergraduate researchers as they are in the lab all day, and are thus available when the faculty mentors are otherwise engaged. By closely working with undergraduate research students, BUILD Technicians gain valuable experience in supervising and mentoring undergraduates. This training prepares them for their future role as graduate students. In addition, Xavier undergraduate research students benefit from these one-on-one interactions and near-peer mentoring received from the Technicians. As observed by the increased number of faculty requesting to become BUILD technician mentors, Xavier faculty are enthusiastic about this program and recognize its benefit of providing full-time assistance in their laboratories and increasing their research productivity.

2 METHODOLOGY

All Xavier biomedical graduates with GPAs greater than 2.70/4.00 are eligible to apply to the Program, and applications are solicited twice each year for December and May graduates. With their applications, students submit a personal statement describing their career goals and any challenges they have faced over their academic years. The applicants who are likely to pursue graduate studies and seem to benefit most from the training are selected and matched with mentors based on their research interests. Students who are already engaged in research may continue in the same lab or elect to move to a new lab. BUILD Technicians are considered full-time university staff receiving a monthly salary and all employee benefits, including tuition waivers, allowing them to take one course per semester at no cost. Interested faculty also complete applications to the Program and are expected to have funding support for their ongoing biomedical research projects, a track record of publication, and experience supervising and mentoring students in research.

To ensure that faculty mentors are well-trained in the different aspects of their mentoring relationships with their mentees (undergraduate students, research staff including the BUILD Technicians, and/or junior faculty), under Project Pathways, a comprehensive mentor training program, Preparing Mentors and Advisors at Xavier (P-MAX), was developed and implemented. In addition to the faculty mentors, Xavier research staff members, including the BUILD Technicians, who work with undergraduate research students are also required to complete this training. P-MAX is based on the Entering Mentoring curriculum designed at the University of Wisconsin-Madison [9,10]. A complete program cycle begins in the summer with an intensive, day-long workshop, followed by three additional hour-long workshops during the fall and spring semesters. In the summer workshop, foundational topics such as developing a mentoring philosophy; effective communication; goal- and expectation-setting; and implicit bias and stereotype threat as they relate to mentoring are addressed. Topics requested or suggested by participants are reserved for the semester workshops. The P-MAX training is expected to be available online on Xavier’s website by the end of 2019 in an open source format.

In addition to P-MAX, Technicians are required to participate in the Mentee-to-Mentor (M²M) Program. The evolution of the PTP and input from the Technicians have brought to light the fact that the BUILD Technicians are in a unique situation as they move into the new role of being near-peer-mentors to undergraduate researchers, some of whom they already know, while also continuing to be mentees to their research mentors. The need to support the Technicians in this transition has led to the development of the one-year long M²M Program. The Program consists of regularly-occurring meetings, workshops, and activities that are designed to provide the Technicians with the knowledge and skills needed to successfully navigate the challenges of transitioning from student-mentee to mentee-colleague-mentor. The activities also include targeted support for the graduate school application process (e.g., drafting personal statements and mock interviews); professional development (e.g., pedagogical and grant-writing training); and programming to support the day-to-day responsibilities and experiences of the Technicians (e.g., workshops on taking initiative and owning their projects, going above and beyond what is required, building confidence, and a healthy work/life balance).

BUILD Technicians are also required to complete Responsible Conduct of Research (RCR) training as mandated by the NIH [11,12]. This training is provided in form of a series of five, two-hour workshops in early summer. The workshops follow the NIH guidelines for RCR training [11,12]. Participants practice recognizing ethical problems in research and resolving them in a well-reasoned manner. They examine the prevailing legal and professional norms of ethical research as well as the broader values these norms reflect. Specific ethical issues examined include: conflict of interest, treatment of data, mistakes and negligence, research misconduct, intellectual property, use of animal and human
subjects, and the human genome project. Further, the Technicians are required to successfully complete the Collaborative Institutional Training Initiative (CITI) online training courses for the Institutional Review Board (IRB) and Institutional Animal Care and Use Committee (IACUC) members.

The BUILD Post-baccalaureate Technician Program at Xavier provides an opportunity for ‘late-deciding’ students to work closely with a faculty mentor on research projects, gain additional training in research techniques and instrumentation, work with and mentor undergraduate research students, participate in GRE workshops, attend and present at scientific meetings, and take additional courses to prepare for graduate school. The combination of mentored hands-on research and the various soft skills trainings mentioned above provides the BUILD Technicians a competitive edge in their pursuit of biomedical research careers.

3 RESULTS

To provide recent Xavier graduates with research training to increase their preparedness and competitiveness for graduate programs, a Post-baccalaureate Technician Program (PTP) has been implemented under Project Pathways. This initiative provides Xavier graduates with opportunities that are significantly different from those of most other post-baccalaureate programs, including the NIH-funded PREP programs, which are restricted to research-intensive institutions. Most students applying to the BUILD PTP lack the self-confidence and/or preparation for applying to competitive post-baccalaureate programs because they are often undecided about their next academic/career steps until late in their undergraduate years. For these students, applying to a widely-advertised post-baccalaureate program at their home institution is not as intimidating. Also, as these students are known by the faculty and staff at their home institution, their applications are reviewed in a more informed and holistic manner. In addition, familiarity with the faculty and the institution make the transition more comfortable for the students. The mentee/mentor, implicit bias, and stereotype threat training provided to the BUILD Technicians is not common at most other post-baccalaureate programs and better prepare the Technicians, the vast majority of whom are from underrepresented groups, for a smoother transition to Predominantly White Institutions (PWIs) and into employment. Input from the participants and collected assessment data have been used to make needed adjustments to the Program in order to increase impact and efficiency.

The PTP has proven to be one of the most successful Project Pathways initiatives based on its high impact and return on investment. Of the 28 Technicians who have completed the Program as of Fall 2018, 21 have matriculated in a graduate program (13 enrolled in PhD programs and 8 enrolled in MS programs); one is enrolled in Xavier’s College of Pharmacy; four are enrolled in medical schools, one of whom originally entered an MD/PhD program but changed his path after the first year in that program; one is seeking temporary employment and another has discontinued her education, both for family reasons. Based on these results, the Program currently has a 75% placement rate in graduate programs. All but one of these Technicians were from underrepresented populations. Currently at the end of its fifth year, the Program is still too young for terminal degree attainment outcome analysis.

Both the NIH PREP and BUILD initiatives were developed as part of the greater effort by the NIGMS to promote, support, and sustain the development of a highly skilled and diverse biomedical workforce (NIGMS Strategic Plan) [13]. A 2015 outcome analysis report of the PREP programs (2001-2014 data) showed that about 16% of PREP Scholars came from HBCUs, and 22% came from Hispanic-Serving Institutions (HSIs), while about 50% came from primarily White doctoral and research-intensive institutions [14]. Sixty-four percent of the PREP Scholars in that report matriculated in PhD programs [14]. Of the pre-2007 Scholars in the study (501), 191 (38%) had attained a PhD equivalent (PhD, MD-PhD, and PharmD), 79 (16%) had obtained a Master’s equivalent (MS, MA, MPH, MBA, and MPT), and 63 (12%) completed a medical degree equivalent (MD, DO, DDS, DVM, and OD) as of the date of the 2015 report [14].

4 CONCLUSIONS

The preliminary results, as of the end of Project Pathways’ fifth year, point to the success of the PTP initiative and its potential as a transferable model program. For most institutions, external funding is necessary to maintain a similar program, thus as currently done at Xavier, faculty should be strongly encouraged to include funds for post-baccalaureate technicians in their grant applications.

When comparing the outcomes of the PTP with most other post-baccalaureate programs, including the NIH-funded PREP programs, it is important to note that the applicants to those programs are self-selected with academic plans for seeking terminal degrees. Conversely, many PTP applicants are
undecided and/or underprepared, and based on our experience, would potentially not pursue graduate studies without this program’s intervention [15].

To emphasize, the PTP has been successful in adding students to the biomedical research pipeline who might not otherwise have pursued graduate degrees. This is a significant difference from other post-baccalaureate programs including PREP programs. In its first five years, 28 recent Xavier graduates have completed the PTP and 75% of these participants have matriculated in Masters or PhD programs. The experience of full-time hands-on mentored research, complemented with the sense of autonomy in the lab, the leadership development opportunity provided by mentoring undergraduate researchers, and the opportunity to attend conferences and network with other scientists contribute to the success of the Program.

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REFERENCES


