An Institutional Coordinated Plan for Effective Partnerships to Achieve Health Equity and Biomedical Workforce Diversity

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The rapid growth and accumulation of specialized knowledge in today's biomedical fields, combined with entrenched and emerging health issues that persist among certain groups within the US population, emphasizes the significant need to diversify the nation's biomedical science workforce. The under-representation of minorities in science results in inadequate scientific input from divergent social or cultural perspectives and detracts from our nation's ability to resolve health disparities. The University of North Texas Health Science Center at Fort Worth has developed a coordinated approach with local, regional, and national partners to increase participation of underrepresented students along the career pathway from K-12 to faculty level. Career stage specific activities that include research, mentoring, networking, career development, grantsmanship and health disparities curriculum are provided for participants. Successful outcomes from our coordinated plan includes an increase in participant self-efficacy, research presentation awards, increase in grant awards and publications, and career advancement. Through partnerships within our institution, local school districts, and minority serving institutions nationwide, our coordinated plan provides mutually beneficial co-learning experiences to increase the number of under-represented individuals entering translational research focused on increasing the biomedical research workforce diversity and achieving health equity. *Ethn Dis*. 2019;29(Suppl2):129-134; doi:10.18865/ed.29.S1.129.

Keywords: Diversity; Underrepresented Minority; K-12; Faculty Development

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Introduction

According to the National Math and Science Initiative, the number of Science, Technology, Engineering and Mathematics (STEM) jobs will grow by 17% compared with a growth of 9.8% in non-STEM jobs by 2024.[1] STEM jobs offer 29% higher average salary with better job security. It is estimated that the United States will be short roughly 3 million skilled STEM workers in 2018.[2,3] These statistics signify the nature and scope of the problem and the need to create interventions that will supply the demand for a talented applicant pool for STEM jobs. By 2060, 28.6% and 17.9% of the nations' population will be Hispanic and African American (AA), respectively[4] and significant numbers will represent individuals from underserved and disadvantaged communities.[5] A report by My College Options showed that the overall interest in STEM fields has increased since 2004 by 20% among high school students.[6] However, grave concerns remain due to an increasing gender gap and the ever-growing disparity among under-represented minorities (URMs) choosing to enter STEM fields.[7,8] For racial/ethnic minority groups (Hispanics, AAs, and American Indians), interest in STEM is low. In particular, AAs report the lowest interest (30% decrease since 2000) in STEM compared with any other ethnicity.[9]

Barriers for entry into STEM fields, particularly for URMs and first-generation students, include cultural competency, language, STEM literacy, and parent-student-teacher communities.[10,11] Historically, efforts to increase entry and retention of URMs and underserved populations in STEM fields focus on the baccalaureate and post-baccalaureate years through funded programs offering financial assistance, academic tutoring, career advising, research internship and health care shadowing experiences.[12-15] However, the lower than expected numbers of URMs earning STEM degrees and entering STEM career paths, and the small noted gains of the success of STEM programs raise the implication of their efficacy, and questions of continuance. Such trends suggest the broader inclusion of programs that capture participation across all academic levels. Thus, there is a critical need to develop a

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coordinated approach that begins at the formative pre-college years and continues through the various career stages in order to achieve a diverse research workforce in the country. In this article, we provide an example of an institution's approach in integrating comprehensive STEM careers for diverse populations cognizant of the value in providing multiple opportunities to receive training and experiences noted to motivate and sustain persistence in STEM careers.

Methods

The University of North Texas Health Science Center (UNTHSC) at Fort Worth created a novel coordinated plan to address the need to increase URMs in biomedical education and research (Figure 1). The plan includes both funded and non-funded programs designed to: 1) enhance awareness of educational opportunities for students in K-12; 2) provide training in both academic skills and focused biomedical research for under-represented college students from partner institutions; 3) increase financial and economic opportunities for graduate students during both masters and doctoral studies; and 4) provide grantsmanship and career development skills for postdoctoral fellows and junior faculty. The coordinated plan is dynamic with new programs added and unfunded programs removed, but the overall structure, activities, and outcomes are sustained.

The coordinated plan is built upon a pipeline of programs that are externally sponsored including the following.

K-12 Sponsored Programs

Texas Academy of Biomedical Sciences (TABS); Adopt-A-School and After School programs at the Fort Worth Independent School District; and Coaching UP program at the Arlington Independent School District.

Undergraduate Summer Research Programs

Major undergraduate summer research programs are funded through numerous sources including: National Heart, Lung, and Blood Institute (NHLBI): Summer Multicultural Advanced Research Training (SMART); National Institute of Drug Abuse (NIDA): Summer Undergraduate Research Internship Program (SRIP); and the Department of Defense: Prostate Cancer Summer Training Programs. Previous programs included the Ronald E. McNair program funded by the Department of Education.

Post-baccalaureate Program For Health Professions

The Student Access to Medical Education (SAME) funded by the Texas Higher Education Coordinating Board supports one-year postbaccalaureate education to aspiring URM students to matriculate to medical and dental schools. A previous program, Postbaccalaureate Research Education Program (PREP), was supported by the National Institute for General Medical Science (NIGMS).

Pre-doctoral Training Program In Biomedical Research

The Initiative for Maximizing Student Development (IMSD) funded by NIGMS supports pre-doctoral training for underrepresent minorities, first-generation students, individuals with disabilities, and socioeconomically disadvantaged populations to pursue the doctorate in biomedical research. The NIA-funded Neurobiology of Aging (NBA) supports graduate fellowships in aging research.

Health Professional Research Training

The NHLBI funded Promoting Diversity in Research Training (PDRT) and the Cancer Prevention and Research Institute of Texas (CPRIT) funded "Osteopathic Scholars in Cancer Research" (OSCR) to support short-term and dual-degree research training for health professional students.

Post-doc and Junior Faculty Training

The National Institute for Minority Health and Health Disparities (NIMHD)-funded Specialized Center of Excellence in Health Disparities (COE) and the NIGMS-funded National Research Mentoring Network (NRMN) provide research and mentoring to graduate and heath professional students, post-docs and junior faculty.

Typically, training for the K-12 students include science mentoring, hands-on workshops, coaching-up programs, after-school programs and role models. Summer undergraduates, post-baccalaureate and pre-doctoral students receive research experience, an introduction to health disparities, life-skills workshops, interprofessional education, and communication skills. Postdocs and junior faculty programs are geared toward grantsmanship as well as grant-writing skills and leadership development for career building.

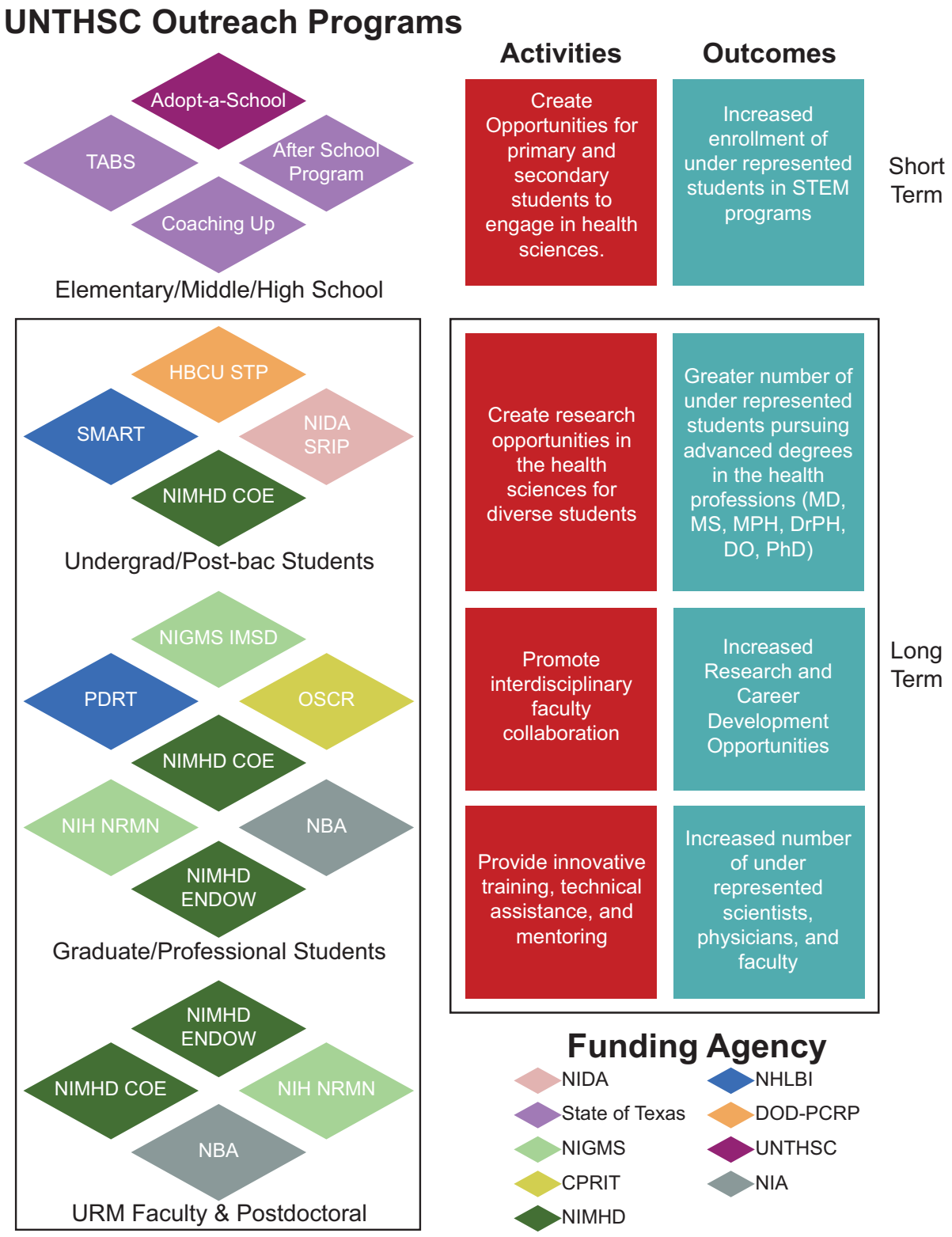

Figure 1. Coordinated plan to increase biomedical workforce diversity
Programs to support mentorship and research training at various career stages from K-12 to faculty along with activities and expected outcomes.

Results

The diversity training programs at UNTHSC began in 1982 and have continued to date. While data from earlier years are not complete, we have reliable data from programs since 2000. At each career level, various programs supported by extramural funds are operational and Figure 1 illustrates the programs that formed the Coordinated Plan in 2018. The total funds invested through extramural and intramural support from 2000 to 2018 exceeds $30 million. Table I shows the number of trainees at each career stage who have participated in the UNTHSC programs.

Collaborative programs with the Fort Worth and Arlington Independent School Districts that span 2002 to present have reached more than 7,500 students. Participants were exposed to campus tours, hands-on-training and role model seminars. One of the significant programs at the K-12 level is the Texas Academy of Biomedical Sciences (TABS), an early college preparatory program for high school students. Among the 7,531 K-12 participants, 83% are from URM groups and 62% are female.

Numerous institutional partnerships have been established with historically Black colleges and universities (HBCU), Hispanic-serving institutions (HSIs), tribal colleges and universities (TCUs) and majority institutions. Programming spans undergraduate to faculty career levels from universities and colleges in many states and Puerto Rico. Figure 2 shows the geographic distribution of participants in one of our undergraduate summer research programs (NHLBI-SMART) and our junior faculty development program (NIMHD-STAR), demonstrating the robust partnerships established with various institutions from where the participants travel for the program. Table 1 shows that 82% of the participants in our summer undergraduate training programs come from minority-serving institutions (MSI). Similarly, a significant proportion of post-baccalaureate trainees (64%) and postdocs and junior faculty (45%) have historically been recruited from MSIs for our programs.

Through the institutional partnerships, we have provided training for 762 undergraduate students (56% female; 91% URM), 25 post-baccalaureate (72% female; 91% URM), 229 pre-doctoral and health professional students (66% female; 51% URM), and 150 postdocs and junior faculty (60% female; 55% URM).

Table 1. Summary of programs and the total number of trainees in the Coordinated Plan, 2000-2017

Programs	Number of trainees	Sex, % female	URM, %	MSI, %
K-12 programs	7531	62	83	NA
Summer undergraduate training	762	56	73	82
Post-baccalaureate	25	72	91	64
Pre-doctoral	229	66	51	NA
Post-doc and faculty	150	60	55	45

URM, under-represented minorities; MSI, minority-serving institutions – the percentage of trainees holding residence at minority serving institutions during program participation.

The longevity of each program is sustained by the long-term success of its participants. We continue to follow participants' progression along their academic and professional careers. Post-doctoral and junior faculty participants have garnered in excess of $8 million in extramural research funding.[16] This success is linked to the overall productivity in their careers. For example, past participants of our STAR Fellowship Program have produced more than 130 scientific manuscripts that have been published or are currently in final stages of preparation. In addition, most past post-doctoral fellows and junior faculty have advanced in their career (eg, faculty appointments, promotion and tenure). Since 2008, 84% of former IMSD pre-doctoral participants have earned doctorate degrees and 100% are pursuing academic, industrial, or government research positions. In addition, 82% of our SMART participants earning a bachelor of science (BS) degree are either currently enrolled or have entered biomedical research or health professional career paths.

Discussion

Elimination of health disparities and increasing the quality and years of healthy life free of preventable disease, disability, and injury are two of the overarching goals of Healthy People 2020.[17] Studies have shown that URMs who choose a career in biomedical research are motivated by their interest in reducing health disparities in their communities.[18,19] However, a report from the National Academy of Science Foundation un-

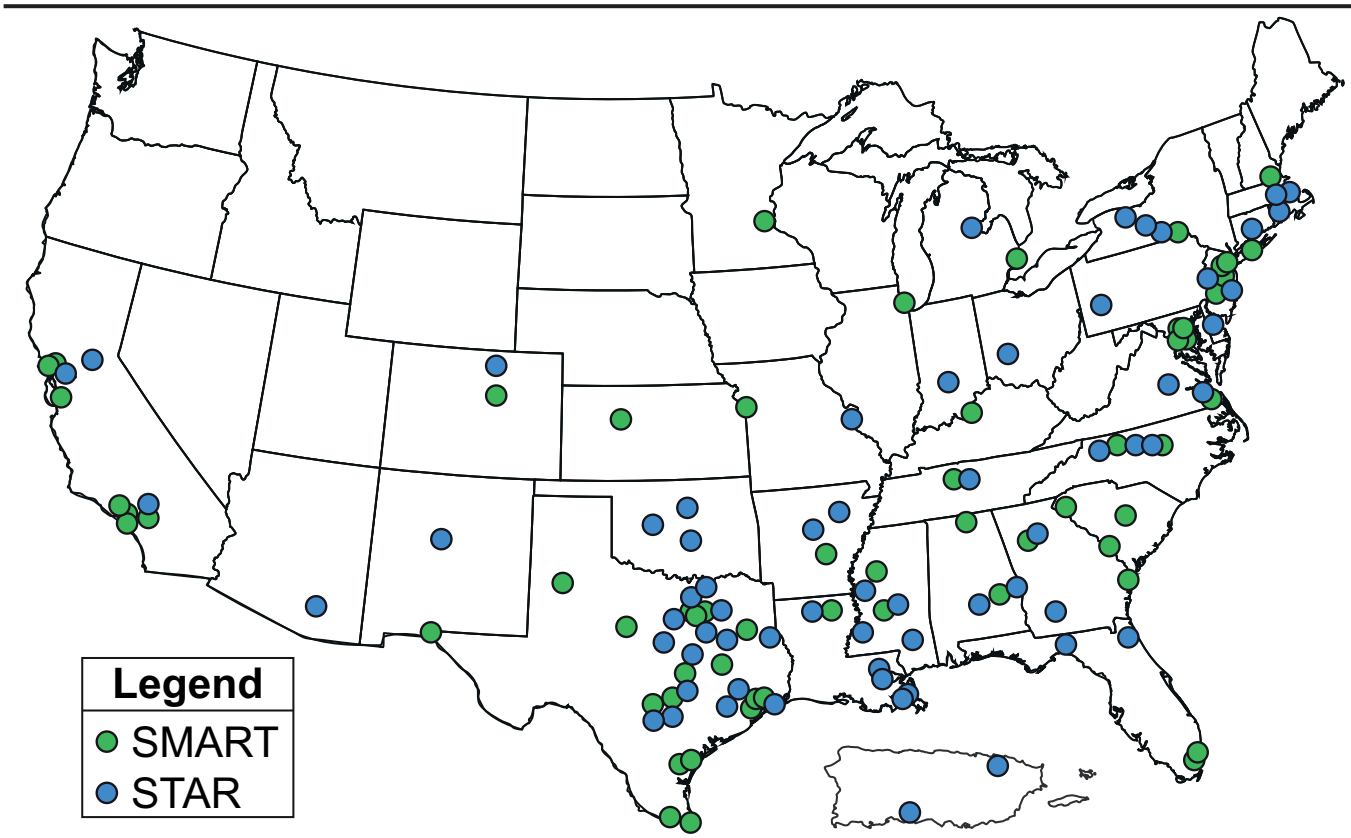

Figure 2. Geographic distribution of mentees in the UNTHSC Diversity Training Programs..
An undergraduate program (NHLBI-SMART) and a junior faculty program (NIMHD-STAR) are shown as representative geographic distribution of mentees. Each dot is a ZIP code of the institutional partner from where the trainees came and does not denote absolute number of trainees.

derscores the under-representation of women, African Americans, Hispanics, Native Americans, and individuals with disabilities in the science and engineering workforce.[20] By the year 2050, the number of African Americans, Hispanics, Native Americans, Native Hawaiian, and Pacific Islanders is projected to increase to nearly half of the US population. As these trends continue, improving health prevention and advancing medical discovery through research will rely upon the training and inclusion of URM populations and disadvantaged populations. Thus, engagement and education of under-represented and URM populations in biomedical and behavioral sciences research is of critical public health importance.[21] Without sustained efforts to recruit and retain well-qualified students and faculty representatives of these groups, there will be a shortage in the scientific workforce; this shortage could have a negative impact on the US economy and the general health of its citizenry.

Increasing the participation and success of URM groups in STEM careers is likely to be achieved by providing enrichment and training programs spanning pre-college thru junior faculty career levels. For example, currently, only one in six (16%) of adults earning a bachelor's degree or higher belong to URM groups and even fewer are expected to earn master and doctoral degrees in the biological sciences than the number earned by their White counterparts over the span of the next 10 years.[22] Based on the continued loss at every transition stage within the STEM academic paths, there appears to be a need to identify mechanisms of retention built around motivation to pursue, skill/knowledge acquisition, and long-term professional development. In addition to the dissemination of best practices for increasing the STEM pathway across various career stages, the UNTHSC's Coordinated Plan provides a platform for assembling programs across all academic levels within an institutional environment. In this setting, program directors, academic partners and institutional administrators are able to

discuss the barriers relevant to each participant's career stage and with this information consider best practices of how to leverage gains of each program progressively, from each transition level to the next. Using this approach, we are beginning to understand where we lose URMs and underserved groups from biomedical research pathways and through the Coordinated Plan, UNTHSC will continue its efforts across all academic transition points.

Acknowledgments

The authors acknowledge the contributions of former and current colleagues toward the Coordinated Plan, including Drs. Thomas Yorio, Robert Kaman, Bruce Dubin, Meharvan Singh, Rustin Reeves and Amalendu Ranjan. Administrative support from Patricia Baker and Heather Longtin is thankfully acknowledged. Research reported in this publication was supported by awards from the National Institutes of Health (U54GM119023, U54MD006882, S21MD012472, T32AG020494, R25GM125587, R25DA043225, R25HL125447, R25HL007786), Department of Defense (W81XWH-16-1-0145), Cancer Prevention and Research Institutes of Texas (RP170301) and Texas Higher Education Coordinating Board (MHGP-13687). The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Vishwanatha, Basha, Nair, Jones; Acquisition of data: Vishwanatha, Basha, Nair, Jones; Data analysis and interpretation: Vishwanatha; Manuscript draft: Vishwanatha, Basha, Nair, Jones; Acquisition of funding: Vishwanatha; Administrative: Vishwanatha, Basha, Nair, Jones; Supervision: Vishwanatha

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