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Strategies for Increasing Diversity in the Ocean Science Workforce Through Mentoring

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ABSTRACT. Establishing and maintaining a diverse US workforce that fully engages all populations represents a tremendous opportunity not only for furthering ocean science-related enterprises but also for cultivating future global ocean science leaders who collaborate effectively to make discoveries, achieve solutions, and develop technologies. A growing body of evidence suggests that a more diverse professional US workforce that better reflects the nation's demographics can be achieved through numerous strategies aimed at effectively recruiting, supporting through graduation, and facilitating the increased participation of underrepresented minorities in Earth, atmospheric, and ocean sciences (and other related) graduate degree programs. To provide background and context for understanding the diversity challenge, we first describe expectations for the future US population and compare these projections to information about today's demographic realities and the situation for the geosciences (including the ocean sciences) in particular. Descriptions of several specific implementations provide examples of successful strategies and reflect the research-based positive factors shown to foster increased engagement of underrepresented minorities.

INTRODUCTION

Why does increasing diversity in the ocean science workforce really matter? Research shows that diverse groups of problem solvers outperform groups of the best individual problem solvers (Page, 2008), and that diversity strengthens scientific collaborations and scientific ingenuity (Page, 2008; Committee on Science, Engineering, and Public Policy and Global Affairs et al., 2011). Racial, ethnic, and socioeconomic diversity is more than a matter of equity. Diversity is the substance of social and economic vitality and global leadership. It is the synergistic leadership, and the collaborative contributions of women and men of various backgrounds, beliefs, and cultures, that will best advance solutions to global issues and challenges. Simply put, increasing diversity in science, technology, engineering, and mathematics (STEM) fields, including ocean sciences, is essential for maximizing and fostering progressive innovation that is critical to scientific discovery and addressing humanity's biggest challenges.

Establishing and maintaining a diverse US workforce that fully engages all populations represents a tremendous opportunity for not only furthering ocean science-related enterprises but also for cultivating future global ocean science leaders who collaborate effectively to make discoveries, achieve solutions, and develop technologies. Karsten (2015) suggests the Collective Impact model of Kania and Kramer (2011) as a potential framework for effectively addressing the need for increased participation of underrepresented minorities (URMs) in geoscience (hereafter, Native Americans, Alaska Natives, Blacks or African Americans, Hispanics, Native Hawaiians, and other Pacific Islanders are referred to as URMs). This broad-based and concerted approach that includes industry partners, academic and civic institutions, and individual change agents can facilitate the retention and production of URM ocean science graduate degree recipients by facilitating focused strategies across the entire professional and educational STEM system. Specifically, a number of positive factors have been demonstrated to foster increased URM engagement throughout the STEM educational pathway. These factors include, but are not limited to: (1) early exposure to STEM fields during K–12 years (Fullilove and Treisman, 1990; Oakes, 1990; Fries-Britt et al., 2010); (2) culturally relevant pedagogy and science relevancy (Ladson-Billings, 1995; Nelson-Barber and Estrin, 1995; Shujaa, 1995; Rolon, 2003; Denson et al., 2010); (3) self-efficacy in STEM (Colbeck et al., 2001; Stevens et al., 2004; Perna et al., 2009); (4) authentic science engagement (PCAST, 2012); (5) availability of role models (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline et al., 2011); (6) participation in afterschool and summer learning opportunities (Howard-Brown and Martinez, 2013); and (7) having mentors (Pfund et al., 2006; Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline et al., 2011). Of the positive factors listed above, mentoring can play a critical role for recruiting, retaining, and producing more URMs with undergraduate and graduate degrees who are well prepared to pursue ocean science careers, and as such is the primary focus of this article.

BACKGROUND

A diverse US STEM workforce is needed so that the nation can sustain innovation and competitive advantage (Page, 2008; Cooper et al., 2011) and attract enough workers to fill critical STEM jobs (US Department of Energy, 2014). Unfortunately, statistics show significant underrepresentation of racial and ethnic minorities throughout STEM overall and in the educational programs leading to STEM careers. Underrepresentation is even more of an issue within the ocean sciences. As Lettrich (2014) and Cook et al. (2016, in this issue) point out, while there have been upward trends in the core marine discipline degrees granted (especially for baccalaureate degrees), URM graduate degree attainment in these disciplines remains essentially flat. To provide background and context for understanding the diversity and mentoring challenge, we first describe expectations for the future US population and then compare these projections to information about today's demographic realities. We continue with data about the overall scientific and technical workforce and educational system and conclude with a discussion of the situation for the geosciences (including the ocean sciences) in particular.

The Demographic Challenge

The US Census Bureau predicts that, by 2060, minorities (defined as all groups except for the single-race, non-Hispanic white population) will comprise 57% of the population, with expected URM population increases from 2014 to 2060 (Table 1). Given this major demographic shift over the next 45 years, what does underrepresentation look like in the workforce today both across STEM fields in general and specifically within the Earth, atmospheric, and ocean sciences? What opportunities lie ahead for URM individuals in the geosciences?

STEM Workforce Patterns

The National Science Foundation Women, Minorities, and Persons with Disabilities in Science and Engineering reports (NSF, 2015) consistently indicate that the US science and engineering (S&E) workforce is composed predominantly of white males (55% in 2013) who represent only 32% of the adult US population, while underrepresented groups constitute disproportionately smaller percentages of S&E degree recipients and employed scientists and engineers (NSF, 2015). STEM occupations are expected to grow by 17% between 2008 and 2018 (Langdon et al., 2011). Focusing more specifically on STEM careers in the ocean and coastal sciences, reports by Gillula and Fullenbaum (2014) and the Gulf Research Program (2014) suggest that in the next 15 years, significant employment growth opportunities exist for URM workers in blue-collar, scientific, managerial, and professional positions.

Educational Patterns Today

Sowell et al. (2015) note that whereas URM students earned 21% of the bachelor's degrees conferred in 2012, they received only 8.5% of the 41,400 doctoral degrees conferred in the same year. And although URMs are the fastest growing segment of the US population, they only represent 5.4% of individuals receiving US S&E doctoral degrees (Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline et al., 2011). The most recent (2015) NSF Women, Minorities, and Persons with Disabilities in Science and Engineering report indicates that in 2012, Black or African American graduate students represented 5.58% (31,338 out of 561,418) of all S&E graduate students and only 1.95% (314 out of 16,069) of Earth, atmospheric, and ocean sciences graduate students (NSF, 2015). While the representation of Hispanic or Latino S&E graduate students in 2012 is quite similar (5.59%; 31,406 out of 561,418) to that of Black or African American S&E graduate students, this demographic represented a larger group (4.59%; 737 out of 16,069) of Earth, atmospheric, and ocean sciences graduate students for the same year. The overall graduate percentages were 0.39% for American Indian or Alaska Natives (2,188 out of 561,418 in 2012) and 0.16% for Native Hawaiian or Other Pacific Islanders (920 out of 561,418). In the Earth, atmospheric, and ocean sciences, American Indian or Alaska Natives represented the third largest group of URM graduate students (0.55%; 88 out of 16,069), and Native Hawaiian or Other Pacific Islanders represented the smallest URM group of Earth, atmospheric, and ocean sciences graduate students (0.087%; 14 out of 16,069) in 2012 (NSF, 2015). For persons with disabilities,

TABLE 1. US Census projected URM population changes (population in thousands; Colby and Ortman, 2014).

	2014	2060	% Change
American Indians and Alaska Natives	6.52	10.16	55.8%
Blacks or African Americans	45.56	74.53	63.6%
Hispanics	55.41	119.04	114.8%
Native Hawaiians and Other Pacific Islanders	1.45	2.92	100.8%

the US Department of Education (2012) reported 5.4% (42,012 out of 833,783 US S&E graduate students) in 2012.

URM Undergraduate Major and Graduate Program Choices

Today's students are making significant investments in their futures, and their choices of undergraduate majors (and subsequent graduate programs) are determined by a variety of factors. In a recent report outlining bachelor's degrees earned by race and ethnicity, the top seven highest paying majors, defined through starting and mid-career median salary, are engineering, computer, and information sciences; mathematics and statistics; engineering technology; health professions; business; physical science; and science technologies (Allison et al., 2015). African Americans are notably underrepresented among engineering, mathematics and statistics, physical science, and science technologies majors, comprising only around 5% of the degrees awarded in these subject areas. Hispanic and Latino students receive 10.1% of bachelor's degrees conferred and comprise an average of only 7.8% of jobs in six out of the top seven highest paying subject areas, with the only exception being in business degree programs. In contrast, African American and Latino students are overrepresented in four out of the six lowest paying majors and three out of the six lowest paying majors, respectively. (The six majors with the lowest salaries are family and consumer science; education; theology and religion; legal and professional studies; homeland security, law enforcement, and firefighting; and multi- and interdisciplinary studies.)

Based on the above data, the degree choices of US URM undergraduates do not appear to be primarily determined by potential salary earnings, but instead may be more heavily influenced by other factors that include (but are not limited to) contributing to positive social change, collaborative and creative approaches to work, and work-life balance (Allison and Mugglestone, 2014).

At the graduate level, underrepresentation is an even bigger challenge. US URMs who are choosing to pursue S&E graduate degrees are disproportionately selecting programs outside of the Earth, atmospheric, and ocean sciences for a variety of reasons that undoubtedly include considerations of relevancy to US URM communities, perceived career placement and advancement opportunities, limited numbers of and exposure to actual URM role models in Earth, atmospheric, and ocean sciences, as well as some more obvious concerns that include what may appear to be a limited job market with less competitive salaries.

One very positive sign is that URM students who have chosen to pursue geoscience careers often cite societal factors as motivating forces underlying their career choices (Institute for Broadening Participation, 2015). If the ocean sciences can be showcased as disciplines that make a real difference for society (and for diverse communities), URM students may be more inclined to consider such careers—especially if workforce opportunities for minorities grow at a faster rate as a result of the demographic shifts projected in Table 1. Indeed, a growing body of research suggests that a more diverse professional US workforce that better reflects the demographics of the population at large can be achieved through numerous strategies aimed at effectively recruiting, supporting through graduation, and facilitating the increased participation of URMs in Earth, atmospheric, and ocean sciences (and other related) graduate degree programs (Huntoon and Lane, 2007).

Retention Challenges and Strategies

While traditional academic degree programs successfully provide many students with the knowledge and analytical skills necessary to pursue a STEM career, many other students, including some URM students, do not persist in these programs and have been found to leave STEM altogether in disproportionate numbers (Benderly, 2015; Sowell et al., 2015). A variety of factors may cause graduate students to withdraw once they have experienced academic life, including some finding their graduate research in conflict with their personal values (Benderly, 2015). For many URMs, social justice concerns are also important, and some may decide to seek fields with an applied human component, such as education, health care, or government work. Economic realities may also come into play for some: the perception of an extended poorly paid graduate school and postdoctoral experience, followed by uncertain career prospects, may persuade some URM students to seek more lucrative and reliable alternatives (Benderly, 2015). In addition to these perceived STEM discipline-based "realities," some potential URM graduate students may also find the graduate school environment to be uncongenial, especially at institutions with small URM populations either on campus or in the surrounding community. In a recent Council on Graduate Schools (CGS) survey of doctoral students, although there were a few references to overt racism or racial discrimination, many URM graduate students emphasized the importance of "fit" with their faculty advisors and the institution's role in helping them identify the "right match." In addition, the value of having mentors outside the department/program, especially individuals who understand the unique challenges faced by URM students was stressed. Some students also suggested organizing a peer mentoring program, where senior graduate students are assigned to mentor new URM students (Sowell et al., 2015).

STRUCTURED MENTORING: A PROMISING APPROACH WITH EXAMPLES

A developing body of research and practice on mentoring reveals an emerging set of successful approaches shown to promote student persistence, degree completion, and professional integration into the STEM community. Mentoring relationships and techniques can make a difference for all learners by keeping them interested and engaged, and while most mentoring approaches cited in this article are effective for adult students of all backgrounds, mentoring in general has a greater impact on students who have not benefited from high levels of institutional, social, or family support for their education (Girves et al., 2005; MacPhee et al., 2013).

Effective mentoring for master's and doctoral students can assume various predefined structures, such as near-peer and peer-to-peer mentoring (Holland et al., 2012), "scaffolded" or multidimensional mentoring (Stassun et al., 2010; Nelson et al., 2014), and culturally competent or cross-cultural mentoring (Crutcher, 2014). It is well documented that mentoring plays a pivotal role in addressing some of the primary factors contributing to underrepresentation in the STEM fields, such as attrition and lack of professional preparation, and it is a critical component of effective instructional practices (Packard, 2011; PCAST, 2012; MacPhee et al., 2013; Johnson, 2014; Nelson et al., 2014). However, extensive adoption of evidence- and theory-based mentoring practices, such as the structured approaches listed above, has remained elusive (Packard, 2011). Indeed, many students and junior faculty may receive little or no mentoring, since it is assumed to happen spontaneously or to come about naturally (Girves et al., 2005), or because faculty may not feel they have enough time. Mentoring activities developed around specific evidence- or theory-based practices can facilitate academic, career, and relational development, and they are particularly important when considering the various academic pathways and professional development of those who are underrepresented.

Purposefully cultivating strong groups of diverse mentors, including peers (at both the undergraduate and graduate levels), postdoctoral researchers, and faculty mentors, and providing role-based training, can be effective in supporting increased diversity in ocean science degree programs. Such support networks can address the unique needs of URM students that may result from a variety of factors, such as a lack role models (Hoffman et al., 2003), diminished academic self-confidence (Essien-Wood, 2010), and implicit and explicit bias (Figueroa and Hurtado, 2013).

Undergraduate STEM students represent the potential applicant pool for Earth, atmospheric, and ocean sciences graduate programs (as well as other STEM graduate programs). As such, undergraduate mentoring programs specifically targeted at potential URM Earth, atmospheric, and ocean sciences graduate students serve as important URM recruitment and retention activities that can significantly impact the total number of URM students recruited to and retained in ocean science graduate degree programs. Given the scarcity of mentoring programs specifically targeted at URM ocean science graduate students, it is important to gain insight from existing URM geoscience and ocean science mentoring and professional development programs that have successfully facilitated the advancement of URM students who ultimately enroll in and complete graduate degree programs. Several successful URM student-targeted Earth, atmospheric, and ocean sciences programs with strong mentoring components are highlighted below. These programs have helped to recruit and retain URMs, and also serve to prepare the student participants for successful professional careers after they complete their graduate degrees.

ASLOMP

http://science.hamptonu.edu/mes/aslo.cfm

The Association for the Sciences of Limnology and Oceanography Multicultural Program (ASLOMP) takes place at ASLO Aquatic Sciences meetings or the co-sponsored Ocean Sciences Meetings and involves pairing undergraduate and graduate student participants with professionals attending the meeting. Mentor-mentee pairs discuss session topics being presented at the meeting and participate in networking activities. Although the program's formal mentoring activities are primarily designed to occur during the meeting, longer-lasting informal mentoring relationships are encouraged. Since its inception, more than 700 students have participated in ASLOMP, and many of them made vital connections during their ASLOMP student experiences. See Duguay and Cook (2016, in this issue) for additional information on ASLOMP.

MIMSUP

http://www.wwu.edu/mimsup/outcomes.shtml

The Multicultural Initiative in the Marine Sciences Undergraduate Participation (MIMSUP) program is designed to increase diversity within the next generation of marine scientists. Junior- and senior-level participants receive intensive training at the Shannon Point Marine Center in the marine sciences and in professional opportunities available to those who choose this career path via academic coursework, research, professional development, and mentoring activities. Center faculty members have developed a two-semester-long program that recognizes that effective mentoring involves significant faculty time commitment. Through screening and selection of potential mentors based on mutual interests and potential for collaboration, students gain perspective on the process of identifying and meeting graduate advisers and finding places in their laboratories. With a matched advisor and individual tutoring, an environment of trust and accomplishment is created for the student that maximizes the time for quality mentoring (Bingham et al., 2003). MIMSUP has significantly enhanced the ability of a student participant to succeed academically and to focus on and achieve career goals. The students who have participated in the program since 1991 represent a highly diverse group: 48% are Hispanic, 25% are African-American, 14% are Pacific Islander, and 13% are Native American and Native Alaskan. About 65% of MIMSUP alumni, after completing their baccalaureate degrees, have gone on to graduate and professional degree programs. Many alumni are now working in marine or related environmental professions. MIMSUP has been recognized as a national model for mentoring, receiving a 2002 Presidential Award for Excellence in Science, Math, and Engineering Mentoring (PAESMEM), which was established by the White House in 1995 to recognize outstanding efforts to mentor URM STEM students.

SOARS

https://www.soars.ucar.edu

During their summer research experiences at the University Corporation for Atmospheric Research (UCAR), undergraduates participating in the Significant Opportunities in Atmospheric Research and Science (SOARS) program are assigned up to five mentors: a research mentor, a writing mentor, a computing mentor, a coach, and a peer mentor. SOARS student participants, called protégés, spend up to four summers doing research. A positive outcome is that over 90% of SOARS protégés have gone on to graduate school, and many have entered the workforce with an MS or have continued on for their PhDs. Since 1996, 171 protégés have participated in SOARS. Protégés' achievements, academic successes, and participation in the workforce include: 31 earned science or engineering doctoral degrees, 90 earned science or engineering MS degrees, 142 earned science and engineering undergraduate degrees, 130 gave oral presentations or were panel participants at national or regional conferences, 361 presented posters at national or regional conferences, and 21 were co-authors of refereed papers published from SOARS research. In 2001, UCAR received a PAESMEM for the SOARS program in recognition of its accomplishments and its modeling of successful URM mentoring strategies that can be effectively implemented at various other institutions.

MS PHD'S

http://www.msphds.org

The Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science (MS PHD'S) professional development program utilizes structured multidimensional mentoring practices to engage distinguished academics, scientific organizations, industry partners, alumni, peers, and representatives of nonscience disciplines to support, increase, and sustain the engagement of URM undergraduates and graduate students in Earth, atmospheric, and ocean science programs. Since 2003, a high proportion (57%) of MS PHD'S student participants began their MS PHD'S experience as graduate students, a feature that sets this particular program apart from the other Earth, atmospheric, and ocean science mentoring programs described above that either exclusively or primarily focus on undergraduate education.

MS PHD'S mentoring, science exposure, and professional development activities occur through a series of virtual and face-to-face experiences in conjunction with the annual American Geophysical Union (AGU) Fall Meeting, MS PHD'S Organizational Partners' (MS PHD'S OPs) meetings, and a capstone experience in Washington, DC (Pyrtle and Williamson Whitney, 2008). Since 2004, MS PHD'S has cultivated MS PHD'S OPs with premier scientific societies and symposia (for list of organizations, see Ricciardi et al., 2016, in this issue) to provide URM geoscience students with opportunities to engage in organization-specific programs that offer travel support, research presentation opportunities, mentoring experiences, and exposure at organizational meetings and conferences. The program mentoring activities are implemented through three primary overlapping functional roles—Program Mentors, Meeting Mentors, and Near-Peer "Dream Team" mentors (for details on each role, see Ricciardi et al., 2016, in this issue)—and provide a complementary blend of mentoring practices designed to support tangible (e.g., professional development, networking, research) and intangible (e.g., emotional, self-esteem, confidence, "sense of belonging") needs of URM students as they complete all phases of the program.

Over the course of more than a decade, the MS PHD'S professional development program has developed and refined print and Web-based mentoring and professional materials, one-on-one mentee/mentor activities, small group professional development workshop sessions, and community-building activities to

> "I've been introduced to incredible opportunities for mentoring, travel, and research; I've been introduced to new scholarship, fellowship and graduate programs; I've been exposed to scientific conferences and meetings, and best of all, I've become engaged and included in a community of my scientific peers who will support me throughout the rest of my career."
>
> *Alexandra Sutton, PhD student, Duke University, MS PHD'S Mentee: Cohort VII*

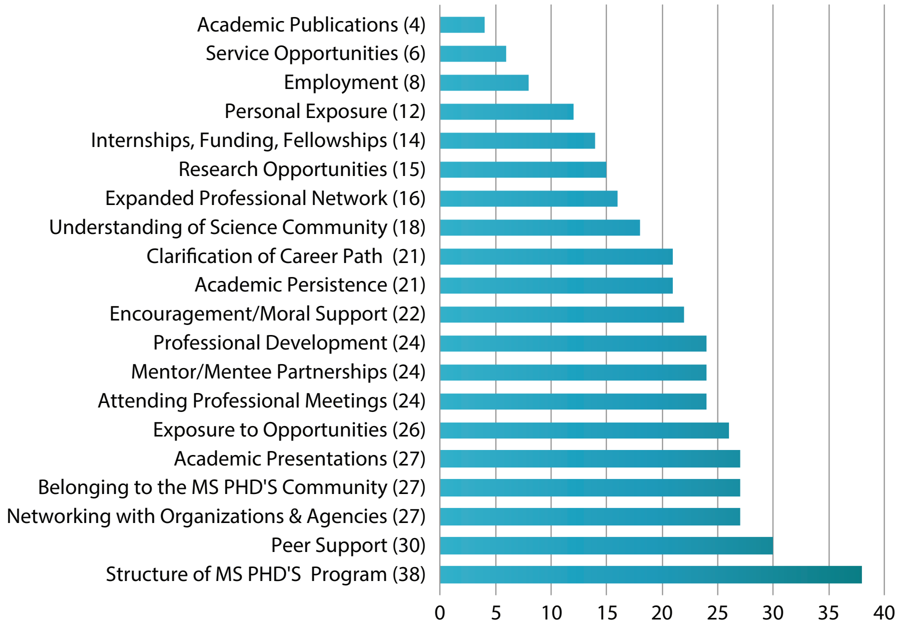

FIGURE 1. MS PHD'S most beneficial aspects based on responses of student participants from 2003 to 2011. *Used with permission of Vivian Williamson Whitney*

support each cohort of participants.

Based upon a survey of participants engaged in MS PHD'S activities from 2003 to 2011, students indicated that they appreciated several unique aspects of their experiences (Figure 1). The benefits cluster around four central themes: networking and relationship-building, professional development, exposure to the science community, and development of URM-to-URM relationships and support, all of which are embedded within the structured mentoring of the program.

Examples from Beyond the Geosciences

Evidence supporting the value of multidimensional mentoring has also come from institutionally based STEM Bridge programs for URM PhD students in physics and engineering at Fisk and Vanderbilt Universities, as well as in molecular biology and environmental sciences at Arkansas State University. Bridge programs, especially at the undergraduate level, address the challenges URM students face in acclimating to college campus life. Findings from these PhD Bridge programs suggest that different URM students may benefit from the same form of mentoring, and that they will seek out and utilize different forms of mentoring according to their self-perceived needs (Siegfried, 2014a,b, 2015). These results corroborate Stassun et al.'s (2010) finding that providing multiple mentoring activities together can be especially effective for promoting URM graduate student retention and degree completion.

MENTORING: MULTIPLE TRAINING APPROACHES FOR FACULTY

In order to promote broad application of best practices in STEM URM student mentoring, multiple channels of adoption should be used: (1) online mentoring manuals and other tools for dissemination and real-time training, (2) on-site workshops, and (3) webinars that can also be used as downloadable adaptable training templates for self-administered training. By utilizing these multiple channels, individual laboratories, departments, and professional education offices gain access to high-quality mentor training though a variety of formats that match their needs. Ultimately, lowering the barriers to participation while supporting a virtual mentoring community of practice increases the likelihood of adoption.

Mentoring Manuals

An example of a commonly used online training tool that can be broadly adopted is a downloadable mentoring manual. While many existing mentoring manuals and training programs promote the recruitment and inclusion of minority students, the Institute for Broadening Participation (IBP) notes that they rarely focus on mentoring approaches that are specifically designed to address known barriers or positive factors related to the URM STEM student experience. In an effort to address this need, IBP developed and published an online mentoring manual[1] specifically designed to respond to challenges typically faced by URM STEM students and to promote high levels of quality student-faculty contact. The manual features best practices and contributions from individuals who have received a PAESMEM in recognition of outstanding mentoring in STEM fields. Examples of other online STEM mentoring manuals are available online.[2]

Workshops for Faculty and Staff

As a strategy for addressing underrepresentation in STEM, professional development workshops for faculty draw on current research-based content and a variety of funding/outreach models for their success. Minority-serving organizations like the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) support the training of faculty and staff in mentoring and a variety of other broadening

[1] http://www.pathwaystoscience.org/manual.aspx
[2] http://www.napequity.org/stem/ee-stem-program; http://idahoepscor.org/uploads/Faculty URM Mentoring Handbook 2014.pdf; http://www.idahoepscor.org/uploads/2014 EPSCoR Mentoring STEM Students.pdf

participation topics through a model aimed at hosting regional and national conferences; providing travel awards that allow faculty, especially underrepresented minority and junior faculty, to participate in regional and national workshops; and linking to a wealth of online resources. One example of a SACNAS-supported workshop particularly focused on broadening participation is the SACNAS 2015 Joint Statistical Meetings Diversity Mentoring Program. As an integrated part of the conference, the program track brought minority undergraduates, graduate students, postdoctoral scholars, and junior professionals together with senior-level statisticians and faculty from academia, government, and the private sector. In addition to providing information on strategies to broaden participation in STEM, the workshop activities included a significant mentoring component, including one-on-one mentor-protégé meetings and peer networking for participants.

IBP also regularly conducts faculty workshops focused on student mentoring, recruitment, and retention. This second workshop model typically removes the burden of additional faculty travel since the workshops reach research faculty or administrators at discipline-specific or regional conferences, which faculty may already be planning to attend, or as a site visit with minimal hosting requirements for the host institution. Workshop content and formats assist faculty and administrators in their efforts to support and mentor students, build partnerships, contribute to the pool of broadening participation best practices, and grow diversity awareness and cultural competency in programs, departments, and institutions across the country. For example, in partnership with COSEE-OS (Centers for Ocean Sciences Education Excellence – Ocean Systems), IBP created the "Be Inclusive II" and "Positive Factors" workshops focused on illuminating evidence-based positive factors, already mentioned in this article, that research indicates support students in successfully entering STEM fields and persisting in educational and professional pathways to STEM careers. From early exposure to STEM fields during the K–12 years to mentoring and a community of support for graduate students, the positive factors that can impact the student experience and build a foundation for future engagement and success in STEM careers are numerous and can be intentionally cultivated (Fullilove and Treisman 1990; Oakes, 1990; Ladson-Billings, 1995; Nelson-Barber and Estrin, 1995; Shujaa, 1995; Colbeck et al., 2001; Rolon, 2003; Stevens et al., 2004; Perna et al., 2009; Denson et al., 2010; Fries-Britt et al., 2010; Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, 2011; PCAST, 2012; Howard-Brown and Martinez, 2013). By developing awareness and knowledge of these factors, faculty can enhance their program activities and mentoring approaches to cultivate positive factors in program environments and curricula. "Positive Factors" workshops were held in conjunction with the 2013 ASLO Aquatic Sciences Meeting and the 2014 Ocean Sciences Meeting.

IBP also developed supporting materials and co-presented a site-based joint workshop called Research-based Information on Diverse 21st Century Students hosted by the University of Maine, School of Marine Sciences, and COSEE-OS. The workshop was attended by 20 administrators and faculty preparing for international undergraduates who would be attending University of Maine's 2014 Semester by the Sea program. IBP's portion of the workshop included activities focused on developing one's own situational cultural competence, and provided faculty with tools and resources they could also use in other teaching contexts.

Webinars as Virtual Training Platforms

This third model provides a strong and relatively inexpensive alternative to face-to-face workshops, as well as a growing selection of engagement opportunities for participants. IBP has found that webinars can help faculty gain insight into strategies and modes that can be used to interact with and support underrepresented students in STEM educational activities and careers. Examples of webinars targeted to faculty can be found at the websites of the Center for the Integration of Research, Teaching and Learning (CIRTL) "CIRTLCasts"[3] and the IBP Resource Library[4].

A final model aimed at reaching faculty that combines all the methods mentioned above is On the Cutting Edge Professional Development Program for Geoscience Faculty[5]. This project is co-sponsored by NSF, AGU, the National Association of Geoscience Teachers, and the Geological Society of America. Broad sponsorship, industry partnerships, and shared leadership support a wide variety of face-to-face on-site and conference-based workshops, virtual engagement via webinars, and a wealth of online resources with subjects ranging from curriculum design to developing as a teacher to managing one's career.

RESOURCES FOR STUDENTS

Professional Development Conferences and Workshops

Professional development conferences and workshops for undergraduates and graduate students can complement structured programs or unstructured mentoring relationships by giving students the skills they need to cultivate their mentor networks, develop their career plans, and fund their participation in academic and research programs. Workshops can have many formats, including small and large face-to-face venues as well as recorded or live webinars. Examples

[3] http://www.cirtl.net/ArchivedEvents
[4] http://www.pathwaystoscience.org/library.aspx
[5] http://serc.carleton.edu/NAGTWorkshops/about

of face-to-face workshops include the National GEM Consortium's Grad Labs[6], the Ford Foundation Annual Conference for Fellows[7], and the SREB Institute on Teaching and Mentoring[8]. These workshops typically provide content on topics such as preparing for graduate school, career planning, grant writing, science writing, and teaching skills. In addition to providing professional development training, face-to-face venues also typically afford the opportunity to engage students in peer-to-peer and student/faculty mentoring through activities with varying degrees of structure.

Professional development webinars offer another avenue for providing students with resources to complement institutional mentoring activities. Examples of webinars include IBP's professional development webinar series on topics such as "Funding your STEM Graduate Education," "Making the Most of your STEM Graduate Program," and "Preparing for a Postdoc Position"[9]. Similarly, podcasts—such as those offered by the Society of Women Engineers[10]—can provide engaging information in the interview format. These virtual tools provide a low-barrier means for engaging students, as they require no travel while also enabling asynchronous participation by students who may view/listen to online recordings on an ongoing basis.

CONCLUSIONS

There is a clear need for a skilled current and future STEM workforce as well as an anticipated need for people who are skilled and have graduate degrees in ocean sciences. To date, URMs have not been fully engaged in a way that is consistent with US demographics. In order for URMs to become more engaged, opportunities to pursue their academic degrees should be provided, as well as active and appropriate mentoring to support their successful engagement in the academic and professional ocean science community. Mentoring strategies may take various forms and are most effective when positive factors such as cultural context and relevancy are taken into consideration in designing programs to meet student needs. And while there is a wealth of information available on many aspects of mentoring, educational research shows that structured training approaches work best to enhance the quality of mentoring and promote the dissemination and wider adoption of best mentoring practices.

It is important to note that these practices and strategies can be readily adopted and applied to various academic institutions and in the classroom to improve recruitment, retention, and graduation of URMs in ocean sciences as well as in other STEM fields. As thoughtfully designed training initiatives are adopted by US ocean science academic degree programs and their institutions, the resulting improvements in mentoring will promote an increase in the participation of URMs in the US ocean science workforce.

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