MEETING REPORTS AND ANNOUNCEMENTS

Inclusive practices for diverse student populations: Experimental Biology 2017

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Science educators are welcoming more diverse student populations into their classrooms, and these educators must understand how their actions as teachers and advisors influence the success of their students. To address these important issues, the Teaching Section of the American Physiological Society sponsored a symposium, “Inclusive Practices for Diverse Student Populations,” at 2017 Experimental Biology in Chicago, IL, introducing practices that promote inclusion in diverse student populations in STEM. The symposium began with an introduction to quantitative and qualitative assessment strategies of diversity and inclusion. The second half of the symposium discussed structural bias and effective inclusive practices.

Defining inclusive practices. The common theme across all four presentations was the necessity for diversity, equity, and inclusion in STEM education. We define diversity as the various demographics within a group (Fig. 1). If all individuals, in this case a diverse population of STEM students, are able to take or create a path to a desired outcome, we define this as systematic equity. Inclusion is present when individuals in diverse populations can take various paths to success, and those individuals are successful (Fig. 1). For the aforementioned diverse population of STEM students, we define success as becoming productive and engaged scientists.

Inclusive practices promote the success of students from various backgrounds and social identities. These practices acknowledge that students bring different skills to the classroom and encourage them to use their own experience and knowledge to enhance their success. Inclusive practices combat barriers faced by all students, but are particularly effective for students who identify as Black, Hispanic, American Indian, and/or Alaskan Native. Students in these groups are underrepresented in STEM (14) and typically face larger and more frequent barriers (36). In addition, students who identify as women, LGBTQ, or nonbinary are often marginalized and face additional barriers (13, 32). It is critical to execute specific and deliberate efforts to retain students who may be deterred from science due to barriers presented by their social identities. Scientific advancement is dependent on new and varying perspectives provided by these students.

Just as collaboration among scientists with diverse laboratory training results in scientific discovery with greater impact, collaboration among scientists with different life experiences is an asset to scientific innovation (23, 35). Students with varying backgrounds will experience traditional STEM training, both undergraduate and graduate, differently. Additionally, those from underrepresented and/or marginalized groups lack role models and support structures for navigating an established and historically white male STEM pipeline (2, 49). Therefore, students who bring new and vibrant skills to STEM may require different types of student-faculty interaction or institutional structures to be successful. The following four sections describe strategies provided by each of the speakers for implementing inclusive practices.
is warranted. Dr. Briggs stated clearly that perpetuation of students from underrepresented population leave the sciences pounding these assumptions are the data that demonstrate poor academic preparation alone is dangerous and racist. Com-

Part 1: Using quantitative data to assess the effectiveness of inclusive practices. Dr. Amy Briggs presented her experiences working with quantitative institutional data to assess student experiences. To determine whether an institution or classroom is equitable and inclusive, systematic assessment is crucial for effective planning and implementation of initiatives targeted to eliminate disparities in STEM education. Many equity initiatives fail because they do not adequately address underlying systemic or institutional issues of inequity. This failure can occur because barriers are unknown or misunderstood (44). Effective assessment challenges institutional assumptions and establishes clear objectives for inclusive learning practices, which, in turn, can be assessed and improved.

When implementing inclusive practices, it is tempting to focus on what you see and hear in your classroom and develop a narrative about the needs of your students. Unfortunately, the creation and reinforcement of this narrative, when constructed in the absence of data and biased through the lens of academe, may not adequately address issues of equity. In fact, a false narrative may preserve or construct practices that perpetuate inequity. It is, therefore, essential to assess systematically the effects of current practices before the implementation of new practices and then continue to monitor the impact of the new practices.

It is probable that aspects of equity in the classroom or institution are considered “givens,” and, therefore, have never been subjected to critical analysis. The use of data to interrogate these assumptions is essential. For example, if a small proportion of students graduating with science majors are from underrepresented populations in STEM, faculty and administrators may assume that students from these groups arrived at the institution unprepared, and the students are not capable of the coursework required for their program. Attributing low rates of students of color graduating with STEM graduates to poor academic preparation alone is dangerous and racist. Com-

faculty and administrators must critically assess what is occurring in their classrooms and curricula (30) by asking such questions as: 

1. Are students from underrepresented populations persisting at smaller than expected numbers, given all-college demographics?
2. How many STEM courses do students from underrepresented populations take in high school compared with their majority peers? How did they perform in these courses?
3. Do the enrollment demographics in introductory science courses align with all-college demographics? Are these demographics maintained throughout the major, or is there a bottleneck in the curriculum that results in a demographic shift?

This list represents just a few questions that start to unpack the complicated issue of persistence. The quantitative data presented from these questions may be surprising and unex-

Dr. Briggs reminded us that successful assessment provides baseline data that assists in recognizing causal relationships and developing realistic benchmark goals to address inequity. More importantly, systematic and strategic assessment provides the opportunity to establish clear objectives and priorities for equity in your classroom or institution. Initial quantitative assessment of classroom and institutional practices can be daunting, but clear and defined research questions serve as guideposts for inquiry and action. Develop questions that are important to stakeholders, such as faculty, students, and admin-

Likely collaborators may include faculty within natural and physical science departments with expertise in the scholarship of teaching and learning, or social scientists, possibly sociol-

Quantitative data are powerful for identifying specific aspects of equity, such as differences in academic performance or persistence. Fortunately, quantitative data are often plentiful, especially at departmental and institutional levels. It is likely that the institution already collects information on student demographics (e.g., race, gender, ethnicity, Pell eligible, first generation, athletics, Greek life, etc.), grade point average (GPA) (overall, major), individual course grades, average course grades, number of graduating majors (discipline, department), and course drop rate (number of students before and after semester begins). Most have the capability to track individual students over multiple years, which may allow for tracking student trajectory and persistence through a major. For example, it may be possible to know which students are continuing on to intermediate level courses after completion of introductory courses. Temporal data also allow for comparisions before and after implementation of inclusive practices.

Many institutions participate in national surveys that provide institution-specific data and national-level data for comparison. The National Survey of Student Engagement is conducted
annually by numerous institutions. This survey provides quantitative data about how students use their time and how institutions encourage students to participate in practices shown to increase student success (29). The Higher Education Research Institute implements surveys, such as the Cooperative Institutional Research Program Freshman Survey and the Diverse Learning Environments Survey, as well as faculty and staff surveys that provide quantitative data about attitudes and behaviors (24, 45). These data are valuable for initial analysis, developing research questions, and pre-/postimplementation comparisons.

The vast amount of quantitative data may be overwhelming, but Dr. Briggs suggests starting with research questions based on casual observations or interesting anecdotes. For example, she observed that underrepresented students in one of her intermediate-level classes avoided in-class student group work. Such observations may help narrow a “first pass” analysis of available data. From this point, develop a feedback loop where the data inform and refine the research question. Then direct the data collection toward information needed to address the specific research question. Continuing Dr. Briggs’ example: Was avoiding group work detrimental to students’ final grades in her class? Why? Were their final grades in earlier introductory biology courses also lower? (This work could be followed up with qualitative data collection around what discouraged underrepresented students from participating.) Once the research question is defined and refined, break the analysis into manageable pieces. Let the data, rather than assumptions, guide the inquiry. Continue to communicate with knowledgeable collaborators, as their experience will help focus the assessment.

Available data may not directly address your research question. Institutional policies may prohibit the dissemination of particular types of information (e.g., breakdown of GPA by instructor) for legitimate reasons. The first approach to navigating this situation is to reevaluate the research question and the data needed to evaluate it. A slight refinement may result in a better match of the available data to the assessment objective. If additional data are needed, engage experienced collaborators to develop data collection strategies with approval from the Institutional Review Board. It is possible that quantitative data may not be adequate to answer specific questions, particularly related to student experience. Qualitative data may be an excellent choice for further investigations. Once again, find collaborators that are skilled and have experience in this type of data collection.

Assessment can be a long process but is critical to the implementation of inclusive practices that are truly equitable. Quantitative data provide an opportunity for faculty and administrators to question long-held assumptions and then employ and monitor appropriate interventions that enhance the likelihood of success for all of our students.

**Part 2: Using qualitative data to assess inclusion and equity.**

Namoonga Mantina then presented her experiences using qualitative assessment tools. Qualitative assessment is critical for implementing new initiatives or successfully eliminating traditional barriers to equity and inclusion. Often, qualitative assessment stems from rigorous and targeted quantitative assessment (15). Quantitative data can provide information about diversity, or the representation of various racial, ethnic, or other social identities present in a group or population, such as in a class or at an institution (Fig. 1). Quantitative data can also reveal which students are persisting through the curriculum and the grades they are earning as they navigate their coursework (44). Therefore, quantitative assessment is a strong tool for assessing diversity, persistence, and academic achievement. However, Ms. Mantina stated that quantitative data lack the ability to determine the lived experience and/or perception of students in any given group, including those that persist and those that choose to leave. While quantitative data provide information about what is happening in the classroom and across the institution, qualitative data are essential for understanding why particular practices are promoting or inhibiting equity and inclusivity (15, 37).

Qualitative analysis is an excellent tool for capturing the reasons and motivations for students’ actions as they progress through undergraduate and graduate training in STEM. Therefore, rigorous qualitative assessment can provide evidence for or against the presence and extent of equity and inclusion (37). Ms. Mantina reminded us that, typically, there is substantial overlap in the assessment of inclusion and equity, with the common goal of assessing the entirety of the student experience, an essential component to persistence and success in STEM (10, 28, 39). Qualitative assessment of student experience is especially powerful at many primarily white academic institutions, as the majority of educators and administrators responsible for implementing equity and inclusion initiatives did not traverse their education in the same way as students from underrepresented groups are now experiencing the academy (34).

Despite the importance of qualitative assessment, STEM faculty are often not familiar with qualitative methodologies, which can lead to distrust or misunderstanding of qualitative findings (15). Often, valid representative qualitative findings are misunderstood as anecdotal or as individual exceptions. Rather than avoid or dismiss this form of analysis, we suggest and encourage training, just as one would when implementing a new laboratory or field research technique. Collaborations and partnerships with established and experienced qualitative researchers, at your own institution or beyond, provide the foundation for rigorous and informed qualitative data collection and analysis.

Qualitative data that successfully assess issues of inclusion and equity address observations, perceptions, and feelings about the student experience (37). Responses to specific prompts can be compared across students with various social identities to determine whether the expressed experiences are specific to students from particular demographics, or whether there is uniformity across social identities. There is additional benefit to open-ended prompts aimed to address issues of student experience (27). Often students provide examples and challenges that are completely unexpected or perceived previously by faculty and administrators to be of little or no consequence.

Previous research, published literature, and specific institutional needs inform effective prompt development. Ms. Mantina provided examples, such as asking students to describe:

1. Their strategies for success when struggling in STEM courses
2. Their perception of support from STEM faculty and other STEM students
3. How aspects of their social identity affect their experiences

4. Ideas for an inclusive and equitable STEM environment

Prompts designed to directly address research objectives are typically part of a thoughtful and intentional series of questions that are devised to promote the greatest likelihood of open, honest, and reliable answers (27).

Various qualitative methodologies can be employed to attain valid and rigorous assessment. Some of the most commonly used methods in academic settings are individual interviews, reflective writing assessment, and focus groups (15). Typically, oral data are transcribed, and all qualitative data are systematically coded (43). The coding process can be conducted in various fashions, ranging from use of validated rubrics to grounded theory, in which themes emerge from the transcribed data. The coding process results in both qualitative (e.g., specific comments and quotes about student experience) and quantitative (e.g., how often or what percentage of students mentioned a theme or topic) data. Despite the methodology, specific attention to the type, style, and order of questions is critical (27). Once again, collaboration with social scientists or teaching and learning professionals is critical to the preparation and implementation of this work. As with all assessment of student outcomes, experiences, and attitudes, Institutional Review Board approval is required.

Student-led student focus groups are a particularly effective method of obtaining qualitative data about student experience (8, 44). Students belonging to key demographics and complementary comparison groups can be recruited to share their perceptions and experiences. Trained and experienced student moderators (2–3 student moderators for 6–8 student participants) guide discussions in response to carefully crafted prompts focused on the overarching aim of the qualitative assessment. Peer-to-peer conversations in student-led student focus groups result in participants who are more willing to provide open and honest responses, decreasing the likelihood of nonresponse bias, an established risk of qualitative data collection in which respondents alter their response in a formal setting (38). When researching issues of equity, these aspects of assessment are particularly important, as students often feel uncomfortable talking about such personal experiences in the presence of faculty and/or staff, especially if those in power are responsible for students’ feelings of inequity.

There are several challenges to analyzing qualitative data, which become particularly problematic when assessing equity and inclusion at your own institution, in your program, or possibly in your own classroom. Reading responses to prompts is extremely powerful and often transformative, but attentive curation of the data must ensure that responses are truly anonymous before being shared with a broader audience. In addition, Ms. Mantina cautioned faculty and administrators to resist considering the responses as anecdotal stories from a few underprepared students, rather than representative responses. Dismissing reported experiences and perceptions is detrimental to inclusion. She suggested that, to avoid this, collaborators beyond the assessed unit should conduct and/or independently confirm the findings. Rigorous research and appropriate implementation of qualitative methodological best practices provide valid and respected results. In turn, this assessment informs strategic and sustainable inclusive programing, benefiting all STEM students.

Part 3: Reflections of a recent graduate: what worked for me and why. Dr. Hawn presented their experiences as an underrepresented student in the sciences. Undergraduate and graduate students in science disciplines are dependent on faculty-student interactions. Teachers and mentors provide foundational knowledge and skills training. The unstated assumption is that these faculty-student interactions and spaces for learning are safe and welcoming to all students. However, Dr. Hawn stated that this is not true, and the barriers to equitable learning are predictable. For students from marginalized populations, a substantial amount of time and energy is spent confronting and reacting to these barriers (31), in addition to the recognized stress and rigor of the STEM educational process.

Dr. Hawn strongly emphasized that students from marginalized and/or underrepresented groups constantly confront the assumption that they do not belong in science. In the classroom, students that fit the traditional white male STEM profile are typically called on more in class and are asked to take on leadership roles more frequently than students from underrepresented groups (13, 47). As “guests” in historically white spaces, students of color are frequently required to reiterate their qualifications and credentials (20, 42). It is assumed that students of color or first-generation students are only present in rigorous STEM programs because they were given a “pass” through diversity initiatives, and they are woefully underprepared and underqualified (11, 20). Blatant acts of racism—literally questioning the physical presence of students—highlight and augment these issues. Daily scrutiny diverts the effort and energy of students away from their studies and research (6, 9, 22).

The historically white nature of science is reinforced within science peer groups. Supportive peer relationships are essential for student success (8). Student group work and peer learning are also required during the implementation of many high-impact educational practices (29). However, training or instruction for the implementation of successful peer-peer interactions is often limited. This leaves students on their own to navigate their own biases and microaggressions. Students are often oblivious to how these aspects of group interactions may impede the learning of others (50). For example, students who were successful in high school science classes by acting independently might not recognize the benefit of engaging with other students in science courses in college. As a result, required group work can result in tense interactions among students, leaving various skills and contributions unheard or unrecognized. Dr. Hawn mentioned that this is particularly true for students from marginalized groups that already struggle to engage in the classroom.

Dr. Hawn has experienced that, when intentionally included, students from traditionally underrepresented groups are asked to provide an opinion or feedback as the “representative” from that population. This act reduces the experiences of an entire group to one person’s perspective. This perspective is often taken as truth for a community, but a single perspective, $n = 1$, is inadequate. Further complicating this interaction, Dr. Hawn also often found that the person asking for the opinion does not realize this error, and that alone can be extremely frustrating. It is also frustrating when the person asking for the opinion leaves with a sense that the response provided by a single person grants permission from the entire underrepresented population. Dr. Hawn has witnessed this sense of
permission used to justify biased actions and/or maintain power imbalance.

Constant questioning by faculty and peers results in feelings of threat and exhaustion. Unfortunately, the narratives of student frustration are typically not believed and/or dismissed, and the cycle of scrutiny persists (7). Once again, constantly confronting, addressing, and navigating these barriers occur in parallel to a rigorous STEM curriculum. For many students, despite their talent and motivation, the additional work load is simply too great.

Furthermore, structural inequalities may have prevented some marginalized students the opportunity to develop all of the skills for traditional academic success. Faculty members may observe marginalized students struggling with a prerequisite skill, or not recognize a student’s strengths, and conclude that the student does not belong. Students from marginalized backgrounds are more likely to be graded harshly and feel imposter syndrome and, therefore, effectively be pushed out of STEM programs (47).

Intentional and systematic change is required to address the added hurdles impeding the success of marginalized students. Dr. Hawn encouraged us to challenge directly the assumption that students feel welcome or engaged. However, this task is typically left for members of the minority, leading to an “us versus them” mentality. Successful changes occur when all stakeholders, including those within and beyond marginalized groups, collaborate. Additionally, group norms and behavior expectations must be established to ensure that these interactions are safe and productive.

In STEM disciplines, as in most of academia, faculty mentors, staff, and students are predominantly white (34). Faculty and administrators, most of whom were educated at primarily white institutions, typically are not trained in or aware of equity issues faced by their students (41, 46, 50). In a parallel and possibly equally damaging scenario, offenders with the best intentions proclaim how students must navigate the system, rather than provide support for students to find their own way (4). The overarching approach must create an environment in which students from marginalized groups feel supported and valued. As an added bonus, these approaches typically enhance learning for minority and majority students.

So how do you create an environment for students to successfully navigate a rigorous STEM program? Dr. Hawn reminded us that true student success only occurs if students feel safe. Providing an environment free of microaggressions, written and spoken derogatory statements, and other physical and emotional threats so students can freely navigate an institution must be the foundational principle of all initiatives. Quantitative and qualitative assessment of student perceptions of threat and support is critical. Believe, further investigate, and act on these data, rather than jumping to the conclusion that “they just can’t handle it.” When institutions fail or have a delayed response to racist or biased acts, whether it be a specific event or systematically biased curriculum or programing, this reinforces feelings of threat.

Faculty mentors can address concerns of safety within their own classrooms, laboratories, and field groups by taking clear and vocal actions that they support students from marginalized groups. For example, they can publicly acknowledge when actions are unjust and/or unequitable. At the most basic level, this could be a class announcement that recognizes some students may feel unsafe and suggesting resources for those students. Remaining neutral or silent on issues of racism or inequity is harmful and sends a clear message that students with concerns will not be supported. However, Dr. Hawn has observed that these actions sometimes result in loss of social and political capital for administrators or faculty members.

Dr. Hawn indicated the importance of providing a diverse cohort of support, including mentors, teaching assistants, and peer mentors that share identities with students who are marginalized. This diversity sends a clear signal that an institution values and provides a safe environment for students and has been shown to increase the likelihood of success. If specific racist or biased acts are occurring on campus or in the community, students must be provided the resources to cope with this trauma, including counselors with whom they share identities.

A struggling student does not mean that the student does not belong at the institution. Dr. Hawn indicated that this student is an opportunity for mentors to guide the student to the information and skills needed to enable the student’s success. Mentors must be able to engage students and recognize their needs. However, all too often, this moment is missed, through either intentional avoidance or unconscious bias, which is interpreted by the student as further evidence that the student does not belong at the institution.

What can faculty, staff, administrators, and students do to support students from marginalized groups if they do not share identities with the students? Dr. Hawn provided a list of recommendations based on their experiences. The strongest commitment is to prioritize and follow through with the hiring of faculty and administrators from marginalized groups. Faculty can create successful learning environments by establishing a pattern of frequent check-ins with students. Students will feel welcomed and supported if mentors believe and understand them as human beings. Students’ happiness and health should matter to mentors and advisors. Explicitly stating this support and defending these aspects of professional and personal trajectory is critical. Truthful and open conversations about work-life balance and providing support during times of crisis are essential steps in this process. Faculty should be open about their own experiences and trajectory. Visual cues, such as photos, art, and posters, can facilitate faculty-student conversations. Promotion of events centering on marginalized people sends a clear message of inclusion. Faculty mentors should strive to provide a sounding board, rather than a definitive road map to success. Dr. Hawn provided a word of caution: mandatory training, safe signs, stickers, pins, and pats on the back for “good work” have surfaced as symbols of change. However, these indicators of support are minimal passive actions, and they must be followed by genuine and personal actions (1).

Within scientific disciplines, academic institutions, and research groups, there is often a language of “fit” representing an institutionalized standard of success based on the historical perspective. Dr. Hawn stated that historically successful candidates, as defined by advancement through tenure, promotion, and institutional recognition, completely immerse themselves in their work (25). These create the expectation that productive and successful STEM professionals must be constantly available, work excessive hours, and have quick turnaround. Dr. Hawn emphasized that this mode of productivity, reflected in
hiring and promotion practices, incentivizes quantity over quality, and could reduce time for effective thought and consideration. This excessive time demand makes these positions undesirable to some lifestyles, such as primary caretakers, eliminating diversity and creativity from science. This mentality is also present in historically difficult weed-out courses. The emphasis on overstretching and high-demand lifestyles in STEM hiring practices and weed-out courses clearly favor individuals free from substantial caregiving or financial commitments. Faculty and administrators must reevaluate their assessment to reflect what is needed to be an innovative scientist, rather than one that fits the traditional mold.

Part 4: Reflections of a faculty member: promoting student success. As a black, first-generation male student, Dr. Woods picked University of California–Berkeley based on looks, because he had no other frame of reference to make the choice. Showing an interest in science, a professor helped him get his first job and an opportunity to pursue undergraduate research. Dr. Woods’ first job as an undergraduate resulted in an introduction to a faculty member at the University of Kansas. Through this introduction, he applied to graduate school at the University of Kansas. However, would they admit him with a 2.6 GPA (albeit at an excellent and prestigious undergraduate institution), a low Graduate Record Examinations (GRE) score, with only one science course, and average letters of recommendation? (Would you?) He was accepted, on probation, only once a faculty member spoke directly to the admissions committee on his behalf.

So, how do Dr. Woods do? Despite what might be considered a lackluster undergraduate career, he earned a 4.0 GPA at the University of Kansas. His doctoral research evaluating the hibernation and life history traits of yellow-bellied marmots was National Science Foundation funded, and his postdoctoral fellowship at Northwestern was funded by Merck. He is now a tenured faculty member. His success would not have been possible except for the personal reference provided by the faculty member who knew his various strengths not portrayed by his GPA and GRE scores.

Who else is being overlooked? How can more of these success stories be supported? Dr. Woods emphasized it is critical to evaluate the metrics used to predict success in STEM. Metrics, such as standardized test scores, are historical selection factors for science education, but are not necessarily predictive of success (21, 40). These metrics can serve as institutionalized barriers, especially for those from marginalized populations in STEM. While it is easy to assess memorized content through multiple-choice tests, various modes of evaluation must be employed to measure nuanced indicators. For example, discussion-based courses could assign a class citizenship grade (rather than a participation grade) and require a written reflection. Laboratory assignments could require novel problem solving, rather than just replicating previous work in laboratory with known outcomes. Engaging science in a breadth of scenarios, including those that are nonwhite centric, such as health disparities, can spark interest and passion from diverse audiences. Individualized approaches to assessment that test skills, agency, and enthusiasm for promoting social change will enhance and retain the STEM pipeline (16, 18). Dr. Woods shared that curiosity, passion, interest, critical thinking, and communications skills are true determinants of scientific success and persistence. Institutions, programs, administrators, and faculty must reframe what they perceive as “high-risk students.” It is critical to consider the possibility that historically underrepresented students are pushed out of STEM, rather than failing out.

A paradigm shift in metrics and assessment must be accompanied by student support that is evidence based and appropriate for the student population. Dr. Woods stated that he was only successful because he received guidance and mentorship throughout his graduate career. Students from underrepresented groups in STEM are particularly susceptible to challenges that will entice them to leave, such as the pull of family obligations and the push of imposter syndrome. Targeted faculty advising and peer mentoring can assist in buffering the effect of these challenges (3, 8, 17).

Programmatic and institutional support can take many forms. One type of institutional initiative is the bridge program that provides intensive training and mentorship for several weeks before the start of college, followed by continued mentoring throughout the first semester or year of the students’

Table 1. Inclusive practices that support diverse student populations

| To Support the Success of a Diverse Student Population | To Achieve This Support |
|--------------------------------------------------------|-------------------------|
| Acknowledge that diversity exists within the student population. | Faculty and administrators publicly recognize, on campus, in the classroom, and in the laboratory, that diversity is present and valued. |
| Recognize that experiences of faculty and administrators are likely different from those of students. | Faculty and administrators interrogate how their own experiences differ from their students. Faculty and administrators encourage other students to do the same. |
| Challenge the assumption that learning spaces are safe for all students. | Faculty, administrators, staff, and students collaborate to create a network of support that includes people who share the identity of marginalized students, specifically in positions of power. |
| Engage in frequent conversations about different professional and personal trajectories. | Faculty and administrators provide continued opportunities for conversations with students about their needs and provide appropriate responses to student needs. Present diverse perspectives and topics to spark interest and passion. |
| Identify characteristics of success that directly align with innovation and contributions to the scientific community. Recruit students with diverse backgrounds into research and internships. This may come in the form of taking on students who demonstrate nontraditional indicators of success. | Faculty evaluate and create assessments that target nuanced indicators of success. Institutions must financially incentivize students and faculty mentors. Faculty must be provided time and professional recognition (toward tenure/promotion) for recruiting and supporting the success of students with nontraditional backgrounds. |
| Demonstrate empathy to students from diverse backgrounds, particularly if students are isolated as a lone representative of a marginalized demographic within a group or class. | Faculty, administrators, and staff must learn how to communicate with and, more importantly, listen to students from various backgrounds. Professional development opportunities to provide vocabulary and strategies are essential. |
undergraduate career. Bridge programs are successful in improving the retention and academic success of students from underrepresented groups in STEM (33). This intense mentoring program, including advising by both faculty and student peers, is most successful when programing connects student participants to departments, programs, and faculty across campus (48). Evidence-based workshops that focus on growth mindset and strategies for college learning also promote student success (12).

Dr. Woods reminded us that the success of student support initiatives is dependent on the actions and perspective of faculty. Typically, faculty are only equipped with knowledge of their own STEM training trajectory. They can lack the framework to understand the perspective of their students, especially if their students are from a different race, ethnicity, gender identity, social class, economic situation, and/or educational background. Unfortunately, most academic institutions are composed of faculty who do not share the experiences of students from underrepresented students in STEM (14, 19). Therefore, faculty are ill equipped to recognize the barriers for these students. In addition, typical graduate and postdoctoral training provides very little mentoring training, with even less of an emphasis on individualized or situational advising (26). Fortunately, faculty can work to gain skills that are critical for the success of students, including those from marginalized groups.

Although STEM training is based on an apprenticeship model, there is an absence of systematic training in mentoring for faculty. Therefore, Dr. Woods emphasized that faculty and administrators must take intentional steps to prepare for the implementation of initiatives aimed at addressing disparities in STEM. Skills and actions must reframe how faculty and administrators communicate with students, faculty, and staff from underrepresented students in STEM. This includes re-evaluating what science is and who can do it. This work must be systematic and integral to the curriculum, rather than extra initiatives that only serve to promote a higher workload and serve as false and empty gestures.

Dr. Woods’ take-home point was this: to achieve diversity, equity, and inclusion, institutions and administration must actively prioritize change that supports it. Incentives for faculty and staff are critical, including compensating time and effort. Sponsoring internal grants and work groups, along with supporting external grant acquisition, is crucial. Promotion and tenure decisions can consider advancement within courses, programs, and departments, as well as contributing to the knowledge of the discipline of inclusion and diversity. Academic support offices for students should be established that complement the work that faculty are doing in the classroom. The highest levels of the institution, including the Chancellor, Provost, and President, must provide a unified and public voice articulating equity as a priority and then support those words with resources.

**Conclusion.** The elimination of institutionalized barriers to equity and inclusion can only be achieved if these barriers are known, recognized, and addressed by faculty and administration. Once the barriers are understood, specific actions can be taken to promote inclusion (Table 1). Individuals from underrepresented groups who have successfully navigated STEM training are the most likely to fully understand the nuances of barriers to equity and inclusion. In addition, those who have navigated different paths through science can provide insight into effective practices to address bias.

The APS Teaching Section Symposium at EB2017, “Inclusive Practices for Diverse Student Populations,” was an introduction to ways in which STEM educators and administrators can promote the equity and inclusion. The suggestions provided by the presenters (Table 1) are integral steps in STEM education reform as we welcome more a more diverse student population.

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**AUTHOR CONTRIBUTIONS**

K.M.J. and N.M. prepared figures; K.M.J. and C.H. drafted manuscript; K.M.J., A.B., C.H., N.M., and B.C.W. edited and revised manuscript; K.M.J., A.B., C.H., N.M., and B.C.W. approved final version of manuscript.

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