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INSIDE

Learning, Knowing, and Doing Physics 1
A Class Centering the Human Experience in STEM 2
About COM and CSWP 2
Two-Way Mentoring 3
APS Opportunities for Mentorship 4

Learning, Knowing, and Doing Physics: A Career-Progression Framework

Donnell Walton, Adjunct Professor, Cornell University.

My PhD advisor and I had one last lunch before I started my first job at Howard University as assistant professor of physics. Another professor joined us at the table in the faculty lounge. During the conversation, academic performance was discussed in relation to professional attainment, or rather its lack of correlation. The two professors discussed 4.0 GPA students going on to mediocre career success and 2.0 students excelling at their professions. Since academic performance didn't directly correlate with career performance, we ideated the concept "with-it-ness" that did. We didn't solve for how to develop or measure this characteristic, however.

A few years later, I joined my current company as an industrial research scientist. Early in my career I asked a senior vice president what type of people the CEO prefers. He said that the CEO surrounded himself with intelligent people. Due to my perception that I fit into that category, I felt confident. The VP continued, "the CEO favors smart people, but I prefer people who deliver results."

Up until that point in time, I believed the former led to the latter--if you were smart, you delivered. The incongruity brought to mind my final grad-school discussion on with-it-ness.

By now I have hired and developed dozens of people, mostly scientists and engineers, across the globe over the past quarter century. I have gained some insights into how to manage a career effectively. This story begins with Sternberg's triarchic intelligence model[1], a model that describes intelligence in three components. The components are analytical, the ability to solve problems similar to those encountered in the past, creative, the ability to solve problems that are different from those previously encountered, and practical, the ability to determine whether the problem is even worth solving. In general, we overvalue analytical intelligence, since it can be easily quantified by IQ, GPAs and standardized test scores, and ignore creativity and practicality.

In looking for a way to explore and leverage the multidimensionality of ability, I propose a career-progression framework for learning, knowing, and doing science. The framework could be applicable beyond science. It is important to keep in mind that these phases can overlap or even cycle according to the specifics of the career path, role, or discipline. (Please forgive the lack of orthogonality, physicists.) I refer to this discussion as a framework, but to extend a construction analogy, this may be better described as a falsework since it is more of a temporary structure with which to consider career planning until a more permanent structure is established to sufficiently support itself. (Neglecting friction and wind resistance, if you will.)

Learning

During the learning phase of our careers, we are in school or new in our role at our job. Our analytical intelligence is heavily relied upon. We are learning and mastering the underlying principles of our discipline here. Additionally, we learn ancillary skills such as taking notes, studying, managing our time, and communicating effectively.

A coach or teacher is needed to facilitate success in this phase. Our knowledge and skill acquisition can be expedited by a person who can help us contextualize and compound our prior knowledge and identify and deconstruct our misunderstandings as needed.

Knowing

Moving from novice to expert is the next phase of our career. During this stage, we apply the principles we learned during the previous phase. The skill of making decisions about what principles to apply and how to choose problems is acquired.[2] In addition to learning how to formulate and pick good problems, we are also learning how to write proposals, journal articles, and other forms of professional communication. Practicum experiences facilitate the transition to this stage. Through the discussion and application of the principles in real-world situations, a research experience or internship enhances the learning process and develops and deepens the understanding of coursework lessons which accelerates the knowing process.

At this stage, the mentor is the requisite facilitator. This person will help us pick problems, tune into funding systems, operate in hierarchical organizations, and develop our persuasion and informational skills. Mentors assist us in converting experience into sound judgment.

continued on page 5

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A Class Centering the Human Experience in STEM

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Spring 2022, Being Human in STEM learning community at Yale.

Entering the PHYS/MB&B 107 classroom at Yale, you won't find lab manuals, problem sets, or chalkboards for lecturing. Instead, you'll find 15 students and 4 instructors gathered in a circle, sharing thoughts and snacks. The topic of the day might be why the percentage of bachelor's degrees in physics earned by black students and by women is ~5% and ~20%, respectively, or shared leadership structures that facilitate organizational change. PHYS/MB&B 107 is a course called Being Human in STEM (HSTEM) and we are not a traditional science class. Instead, we are a learning community of students and faculty, that together, examines how a diversity of identities and circumstances shape the STEM experience at Yale and nationally.

Students come to HSTEM carrying experiences that made them love STEM, change their majors away from STEM, and everything in between. Over the course of the semester, many stories will be shared and everyone learns through the collective experiences of the learning community and readings. In the first half of the semester, topics such as intersectionality, first-generation-low-income student experience, and imposterism in the context of STEM are introduced through a variety of media, including research articles, podcasts, and popular science or news articles chosen by the instructors. In the second half of the course, students take the reins, bringing in topics and content of their choice and facilitating the class discussion. Students bring in a creative and wide range of ideas; STEM education in rural settings, STEM access for incarcerated and formerly incarcerated people, the military pathway to STEM and educational models are just a few of the student initiated topics from last year's class. In the HSTEM learning community, one of our core beliefs is that the students are our teachers as much as they are our students.

The discussions of primary literature help build a framework for understanding the marginalizing experiences students have had in STEM contexts. This reconstructed framework sets the stage for the heart of the course: community engagement through evidence-based intervention projects. As part of the course, students design and implement semester-long intervention projects to advance antiracism, equity and increase belonging at Yale. HSTEM students come with not only a curiosity for understanding, but also a desire to create a better future for STEM. Their passion for effecting change truly comes to life in their intervention projects. The class is seeded with "project pitches" devised by instructors or other campus stakeholders. Once groups have formed and projects chosen, instructors will advise and help students make campus connections, but the design, project planning and execution is entirely student driven. This year the intervention projects were broad and ambitious as always. The students organized two panel events – one focused on student experiences in introductory STEM classes and the other on increasing accessibility in STEM. Another HSTEM group made a digital art piece highlighting anonymous pandemic learning experiences collected from Yale students, both good and bad. Another group developed and implemented a student survey to assess classrooms for ambient belonging, a feeling of inclusion in an environment. The final project group collated information on workshops and trainings addressing diversity, equity and inclusion offered by a variety of Yale offices, generating a much needed central resource. From this research, students pitched an initiative where faculty and staff could display postcards on their office doors signifying which diversity, equity and inclusion workshops they've taken, and to signal they are open to discussing these issues with students.

This course and its counterparts are taught at 13 different institutions as part of the Being Human in STEM National Network1. The first HSTEM class took place in 2016 at Amherst College2, a class co-designed by Dr. Sheila Jaswal3 and Amherst students. Since then the Amherst class has continued through ten iterations with co-facilitators drawn from STEM and non-STEM faculty, staff colleagues from the library and Centers for Community Engagement and Teaching and Learning, and students who are alums of the HSTEM course joining Dr. Jaswal. The wider network has rapidly expanded as faculty have been inspired by the Amherst course and worked with Dr. Jaswal to introduce and adapt the course to their home institutions.

Although there is latitude to adjust the course to the local context of each campus, all HSTEM partner sites follow closely the vision of the inaugural Being Human in STEM course. The core mission is to empower students, in partnership with faculty, to examine, interrogate and reshape the structures that prevent us from bringing our full human selves and identities into STEM spaces or communities. We learn from academic research and from each other about the lived experiences of STEM students in our community, and we use that understanding to form intervention projects that are evi-

continued on page 9

Two-Way Mentoring: How to increase participation of Indigenous/First Nations students in Physics-STEM

Dr. Astrid Morreale, Physicist at the Department of Energy Office of Science.
Julie Nelson, Physics/Engineering Undergrad at Fort Lewis College, Member of the Cheyenne Sioux River Tribe.
Arielle Platero, Physics/Engineering BSc. postbac researcher at Los Alamos National Laboratory, Member of the Navajo Nation.

A brief history

Starting in the 19th century Indigenous and Native American children were forcibly removed from their families and placed in boarding schools operated by the government and religious organizations [1]. During these campaigns children were made to assimilate to the then government's preferred way of life, using coercion and violence. In Canada and the United States mass children's grave sites were found from these Federal and religious boarding schools [1, 2]. This is a troubled legacy that ended only in the late 1960's which has led to trauma ultimately translating to mistrust in non-indigenous organizations when it comes to education. An effective education outreach activity must take into consideration the historical context. Did students experience growing up on a reservation and attend school on a reservation? Did they grow up in a rural, urban or suburban setting and attend a public school or any combination of these circumstances? A useful bit of advice is that in any of these cases finding an indigenous ally may provide cultural relevance and facilitate outreach endeavors. Finding an ally does not imply that the work will be easy nor fast. Outreach in general requires dedication and persistence, it may take years before seeing results.

A word of caution

Claiming that someone is or is not indigenous is a complex subject and can come with consequences. Do not assume anything unless you are 100% sure of your assertions. In laboratories, when students pick multiple ethnic groups on forms (e.g. Hispanic & Native) they are no longer part of the indigenous category for counting purposes. Keep this in mind as one may be undercounting. In the context of education, students may fall into two categories, affiliated to a tribe or non-affiliated to any tribe. We focus only on the former as formal affiliation is a requirement for many public and federal education or grant applications. We refer the reader to the Bureau of Indian Affairs which has an interactive map showing up-to-date recognized tribal geographic information [3].

Teaming up with Minority Serving Institutions (MSI) serving indigenous students.

There are 32 accredited Tribal Colleges and Universities (TCU), which are composed of mostly community or one-year colleges [4]. The Navajo technical college is the largest TCU on the Navajo Reservation which grants B.Sc. degrees, it has two ABET accredited engineering degrees and is in the process of expanding their science program [5]. There are also four-year public colleges that serve Native Americans to which we highlight Fort Lewis College (FLC) in Durango Colorado, an MSI that has a history of serving the indigenous population [6]. FLC was designated in 2008 as one of six Native American-serving, non-tribal colleges by the U.S. Department of Education. FLC sits in the indigenous ancestral lands of at least six recognized tribes. Today it awards more degrees to Native American students than any other four-year, baccalaureate-granting institution in the nation - about 26% of all degrees awarded [6]. Regarding physics graduation statistics, in the year 2016 out of 31 declared physics majors/minors, 11 were granted the degree in physics. While in the year 2020 out of 21 total enrolled majors/minors, only two undergraduates were awarded the degree. While the engineering major/minor numbers are better in terms of initial enrollment, the relative success rates are similar [7]. This is consistent with national statistics which place Indigenous students at less than 0.5% of both the U.S undergraduate and graduate student population [8].

Fig. 1 (Top) UC Berkeley indigenous students. Permission from source: UC Berkeley AIGP program. (Bottom) Graduates at San Juan College. Source/Credit Arielle Platero

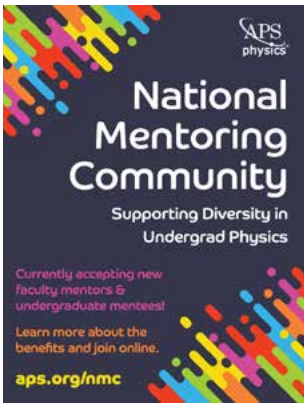
There are a number of explanations as to why these numbers are so low. These include inadequate STEM instruction and resources at the K-12 level and deeply entrenched historical trauma [9]. This minimizes the likelihood for students to have access to advanced place-

continued on page 7

APS Opportunities for Mentorship, Fellowships and Funds for Black/African, Latinx, and Indigenous Undergraduate Physics Students

Dr. Sowjanya Gollapinni (Chair), Los Alamos National Laboratory, Dr. Helen Caines, Yale University, Dr. Roseanne Cheng, Los Alamos National Laboratory,Dr. Vianney Gimenez-Pinto, Lincoln University (Missouri), Dr. Gabriela Gonzalez, DePaul University, Dr. Pablo Laguna, University of Texas at Austin, Dr. Jami Valentine Miller, US Patent & Trademark Office, Dr. Meenakshi Narain, Brown University, Dr. Thomas Searles, University of Illinois at Chicago.

Attendees at the 2020 NMC conference



The APS, together with the Committee on Minorities in Physics (COM), has many initiatives that aim to encourage, support and advertise the success of minority physicists; especially undergraduate students who are just embarking on their careers as scientists. This brief article highlights three of these programs with the goal of increasing awareness of the resources and funds available.

The National Mentoring Community (NMC) [https://aps.org/programs/minorities/nmc/] was started in 2015 to facilitate mentoring relationships between Black/African, Latinx, and Indigenous physics students and established physicists across academia and industry. Although the NMC centers the experiences of Black, Indigenous, and Latinx physics students, any physics student who feels marginalized[1] or minoritized[2] is welcome to join the NMC as a mentee. Membership is free for both mentors and mentees and NMC staff help facilitate mentor and mentee matching. By providing personal and professional development to mentors and mentees, facilitating mentor and mentee relationships, and providing resources to mentees the NMC is taking steps towards creating a future where marginalization and minoritization on the basis of race or ethnicity in physics, and related fields, is a thing of the past.

A benefit to having a mentor is that you have someone that you can meet with regularly to discuss whatever is on your mind. Career advice and heads-up on research opportunities from scientists already working in the field are among the advantages of joining the NMC. Do you need help deciding whether to apply to grad school or enter into the job market? Do you need advice on how to improve your networking, time management or studying skills? Your mentor is there to listen and work through ideas with you. Additionally, both mentors and mentees are eligible to apply for funding to attend in-person conferences and networking events hosted by the NMC. Aside from regular 1:1 meetings with mentors, mentees and mentors come together several times throughout the academic year for virtual NMC Meetups. At these meetups, mentees not only connect with other physics students from across the United States, but also have the opportunity to chat with a variety of NMC mentors about topics ranging from careers, to academics and research.

If you are particularly interested in seeking a career in the industrial sector the APS's IMPact program[3] is another excellent resource for connecting young physicists with industry mentors from around the globe.

Currently almost 24% of the colleges and universities in the US have at least one mentor registered in the NMC, while just over 13% have at least one NMC mentee. With strategic outreach and recruitment efforts launching this year, we aim to exponentially grow the program's community of mentees, while also providing mentors with recruitment tools and resources to help us expand the program's imprint within physics departments. That means we need you! The NMC is always looking for mentors to help fulfill our program's mission. Sign up to join the NMC as a mentor today![4]

In addition to having access to a network of mentors and being a part of a community of mentees, a key benefit to being a NMC mentee is having access to the Bringing Emergency Aid to Mentees (BEAM) Fund. As the name implies, unforeseen emergencies can occur unexpectedly at any time. Frequently they are not only emotionally taxing but also result in financial strain that can threaten one's ability to continue to study. In these emergency cases, BEAM funds are available to NMC mentees.

Thanks to the support of Kenton and Amy Brown, NMC Mentees are eligible for a lifetime amount of $5,000 in BEAM grant funds. Many mentees request between $100 and $1000 at a time to help cover emergencies such as medical expenses, rent, childcare, food, travel for family emergencies, tuition and more. Most BEAM applications are approved within 48 hours of submission and mentees can receive funds within 5 business days after approval. More information about the NMC BEAM Fund can be found on the NMC website[5].

Finally, we want to highlight a new initiative launched in 2022. The TEAM-Up Together Scholarship

continued on page 9

Doing

We face the most challenges at this stage of our careers due to paradigmatic shifts in at least two directions. In contrast to what most of us think about our careers and what we experienced in the prior stages, our careers are not based on contest mobility, but sponsored mobility[3]. In contest mobility, our results and station are determined by our efforts and output. Pushing harder increases our chances of success. It is our belief that this is how the world works for a variety of reasons. Most of our career success is really driven by sponsored mobility--that is, there must be someone above us pulling us at least as hard as we are pushing. There needs to be someone to make sure that our efforts are noticed and rewarded, that we are nominated for awards and recognitions and that we are positioned in good projects. Advocates are needed in rooms where we do not have access. Someone acting on our behalf must be present when decisions are made.

Another shift at this stage is the realization that the world is not deterministic, but rather probabilistic. Efforts and opportunities are often influenced by forces and factors outside of our control. Unlike the early stages of our careers, we no longer have the option of scoring 100% on tests. Our actions can only contribute to the likelihood of our success. There are many factors far beyond our control. Sometimes we fall short in spite of our best efforts. Other times we succeed against all odds. This is great news, since it means we can take risks. As a result, our work can have tremendous, even unforeseeable upside benefits. Another aspect of this nondeterminism is that simply being right is not enough. Since the answers to the problems we are working on are not in the back of the book, people may not know that you are right. We still have to earn attention and convince people to take action. We'd like to be judged by our work and not our words. The fact is that we are judged by the words, our own and others', about our work.

Thus, for this stage of our careers, a sponsor is crucial[4]. We need someone to "carry our papers" into rooms where we do not have access. Especially if we hail from non-elite backgrounds[5]. Due to the behind-the-scenes nature of the sponsorship dynamic[6] and the prevalence of the cognitive bias known as narrative fallacy[7], not recognizing this is a common failure mode. We often find ourselves without sponsors. And even when we are fortunate enough to enjoy sponsorship, it is quite common for our careers to last beyond the retirement of our sponsors. It is possible to continue to believe that the world is deterministic and that our mobility is only a result of our inexhaustible effort. We become surprised when we see better-sponsored individuals surpassing us.

In Sum

In an ideal world, an exemplary research training experience would afford us the opportunity to work with a single sherpa to escort us through these developmental phases such that we emerge from graduate school highly developed and ready to take on the world as a fully formed professional. However, in our non-ideal world, we often leave school with various levels of competencies and experiences as we enter the workforce. To develop our with-it-ness and optimize our career pursuits, we have to master the learning, knowing and doing phases of our professional lives.

To summarize how to do this, I'll share three thoughts. First, a short discussion on how to obtain coaching, mentorship, and sponsorship. The first two are more straightforward. In school, teachers, TAs, other students, and the internet can serve as our coaches to help us acquire the knowledge we need. On the job, we are able to leverage our organizations' in-person and virtual coaching programs, as well as those offered by professional organizations, when we are learning as early-stage professionals.

Our best chance of getting mentorship during the knowing phase is, well, by asking[8]. Just asking for guidance from people who are doing what you want to do. Once again, you can leverage your employer and professional organizations for outreach. We must realize that a mentorship relationship is just that, a relationship. As such, it requires taking some chances, being vulnerable and humble and navigating through some rejection. Getting out of our own way is the key here.

Sponsorship is the most difficult of the three to obtain. In contrast to coaches and mentors, sponsors choose their proteges. Performing well, seeking exposure, having clear career goals, and making your value visible are the best ways to get noticed. If you're feeling particularly intrepid, you may even approach a sponsor candidate with "you know you're my sponsor, right?" Taking this approach requires their understanding of what's in it for them, that is, how they can benefit from your career advancement.

Second, build your network as much as you can. Networking is not a natural ability or inclination for some people, myself included, so it is best to think of it as a skill to be developed rather than a task to be completed. Moreover, we should think of creating and maintaining three networks[9]: an operational network--people with whom we must interact to do our work, a developmental network--people with whom we work to continue to grow personally and professionally, and a strategic network--people who keep us apprised of goings on in the greater universe. The key to all of these networks is generosity and reciprocity--make sure you contribute at least as much as you benefit. Our coaches, mentors and sponsors can hail from our chain of command, but certainly don't have to. The best way to expand our opportunities for these connections is through aggressive networking. That is by serving as a coach, mentor or sponsor, ourselves, as much as possible, as we seek others to serve in these capacities for us.

I'll take this opportunity to stress something that is important, but often non intuitive. In seeking relationships and forming networks, conventional wisdom is to find those who "look like us." An information-theoretic

continued on page 6

Donnell Walton

In general, we overvalue analytical intelligence, since it can be easily quantified by IQ, GPAs and standardized test scores, and ignore creativity and practicality.

analysis of networks shows that seeking connections very different from those we already have reduces redundancy and improves the variety and quality of the information and thus the value gleaned from the network[10]. It behooves us as those seeking coaches, mentors and sponsors, as well as those who would serve in the capacities of being coaches, mentors and sponsors to welcome difference and build more effective open networks.

Which leads to my final thought. Our proficiency with this career progression model occurs when we are willing and able to be the leader for others in each phase—coaching/teaching in the learning phase, mentoring in the knowing phase, and sponsoring in the sponsorship phase.

Our proficiency with this career progression model occurs when we are willing and able to be the leader for others in each phase—coaching/teaching in the learning phase, mentoring in the knowing phase, and sponsoring in the sponsorship phase.

Afterword

If you have read this far and are a typical reader of the *Gazette*, you may be surprised, if not a bit disappointed at my not mentioning ideas like discrimination, disparities[11] conscious and unconscious bias[12], low expectations, macro- and microaggressions, etc., Please do not infer that I am denying their existence or importance. They certainly exist to varying degrees and impact wherever humans can be found. To briefly turn to information theory once again, our brains are bombarded with 11 million(!) pieces of information per second. And we can only consciously process 40, that's four-zero, each second[13]. Overwhelmed, our brains can do nothing but make simplifying assumptions–many of which can be ridiculous or dangerous. At worst, deadly.

I construe the effects of these biases and prejudices like those of a natural disaster. They cannot be prevented and can be predicted with only imperfect accuracy. We can only prepare for their inevitability and buttress ourselves to mitigate their potential damage. Recommending some tools to accomplish this is the spirit in which this article was written.

Acknowledgments

I gratefully acknowledge Nancy DiTomaso, Chris Heckle, Ron Mickens, Jesus Pando, A. Boh Ruffin and Carl Wieman for stimulating discussions and judicious feedback.

Donnell Walton served on the APS Committee on Minorities 2019-2021 and is currently on the executive committee of the Far West Section. He is on the national advisory board for the NSF Inclusive Graduate Education Network (IGEN) and has served on the executive board of the National Society of Black Physicists since 2018. He has worked 25 years as an industrial physicist.

Endnotes

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Two-Way Mentoring *(continued from page 3)*

ment or college preparation in high school. One example of retention rate at the K-12 level is an estimated statistic on the Pine Ridge Reservation, which shows that approximately 30% of the native population will receive a high school diploma [9,10]. Regarding physics and other STEM courses, TCUs themselves have limited courses in astronomy, physics or advanced mathematics. One further barrier to studying potential solutionws is the lack of statistical analyses with Indigenous students. Native Americans are often excluded from postsecondary data and research due to their small sample size. On the inclusion aspect further barriers that students have to face once they arrive at a university is lack of representation and community, sense of purpose, and family friendly infrastructures. It is unfortunate that many of our indigenous students often face offensive environments which include ethnic and cultural discrimination. Finally many non-MSI institutes have their own home grown roadblocks which include strict GPA thresholds, lack of per-diems or dependent/housing allowances including income based childcare options.

With all of these barriers surrounding students, one may wonder are there any indigenous physicists? The answer is YES. Despite the number of barriers there is a community of indigenous physicists, indigenous scientists, and engineers in STEM fields, many who the authors of this article have met over the last years. The most common aspects one may find is that indigenous scientists are engaged, full of insight and with outstanding research achievement records [11,12]. If you look you will find them. One way that one can reach out as a physicist/aspiring physicist to relevant resources is by making use of established professional organizations. While there are many organizations that help foster a sense of belonging and success we focus on two: APS and AISES. APS has a bridge program which gives a number of resources to students wishing to apply to physics graduate school as well as potential hosting mentors [13]. APS also hosts the National mentoring Program which includes the career mentoring fellows which has a two-way benefit to mentors and mentees [14]. The American Indian Science and Engineering Society (AISES) does not currently have a bridge program, but they do provide many other resources for its members including a networking platform, various scholarships, and annual conferences [15]. There are different AISES chapters across the US and Canada divided by region, these can be useful when you are trying to reach out to certain communities in your region or when trying to find STEM allies.

Fig. 2 (Top) Pupils at Carlisle Indian Industrial School, Pennsylvania, c. 1900. Source: Wikimedia Commons. (Bottom) A makeshift memorial for the dozens of Indigenous children who died a century ago while attending a boarding school that was once located nearby is displayed under a tree at a public park in Albuquerque, N.M., on July 1, 2021. Source: AP Photo/Susan Montoya Bryan.

Mentoring

Often, indigenous students are cultivating their identities throughout their educational careers. They are rebuilding their culture, strengthening moral values, processing severe intergenerational trauma, and confronting the pain of centuries of dehumanization while gaining self-esteem as they advance their education. While some mentoring techniques may be applicable to many other groups, it is important to keep in mind a few basics when working with indigenous groups. It is important to maintain a sense of purpose, be inclusive, engage in public outreach and mentoring experiences, participate in workshops, and resource group participation (e.g. indigenous groups, student organizations, professional organizations). Be ready to have ample resources available that will allow students to keep engaged and continuously network. A key aspect to remember is that family is first: we cannot decouple this if we want to be successful, what this translates to is that in our modern times one needs to learn to be flexible. Clear communication and goals while it is a general recommendation it does require work. Vague projects only lead to demotivation and possibly quitting. Constructive criticism is important as acknowledging and recognizing the work of students. Mistakes are also part of the learning experience, so genuine understanding and positive encouragement is necessary. We emphasize that GPA is not a universally accepted reflection on one's capabilities, do not let your students become discouraged because of a bad semester. We note that many of the mentoring techniques in this paragraph can be found in more detail here [16].

continued on page 8

Two-Way Mentoring *(continued from page 7)*

Fig. 3 Authors at the LHCb experiment at CERN Switzerland which is the focus of their research. Julie Nelson (Left) and Arielle Platero (right) from FLC and LANL, are recipients of a DOE Research Traineeship to Broaden and Diversify Nuclear Physics [17] .

Striving together with a global perspective

Physics can only excel by including more students with diverse backgrounds. Indigenous students from our own high energy physics experience often see the scope on longer terms, beyond their project. They have excellent management and leadership skills, they are often direct, to the point while avoiding verbosity and maintaining the lines of respect. Their work or the work of others is not inflated, which translates to personal accountability and being excellent peer reviewers. Honest responses are given when their opinions are sought out. Students from these backgrounds often have a quicker grasp of subjects as they tend to see the global picture and consequences. They are grounded with realistic expectations of results. They have a strong desire to return home and contribute to their communities as professionals and mentors.

Final words

Do your research to learn about the local indigenous communities and schools. Make first contact and maintain it, be patient and persistent. Engage with the community and students to gain a sense of their needs and boundaries. Confront any unconscious biases you may have based on the dominant narrative and reconsider these ideals as you learn from students, the community, and your initial contact. Consult established indigenous physicists and ask them for advice in mentoring. Make use of existing professional societies and their mentoring resources. When targeting K-12, start out with STEM festivals or institute initiatives that benefit reservations or nearby communities next to them. When targeting higher education: work on clarity, outreach experiences, provide role models and networking opportunities. Help lower the barriers at institutes. Finally, try to learn from your students, they do bring a new perspective in research.

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3 *https://biamaps.doi.gov/*

4 *Tribal colleges: https://sites.ed.gov/whiaiane/tribes-tcus/tribal-colleges-and-universities*

5 *http://www.navajotech.edu/*

6 *https://www.fortlewis.edu/*

7 *Private communication FLC 2021 Dean of Physics and engineering department*

8 *https://www.energy.gov/sites/prod/files/2018/02/f48/begay-stem-education.pdf*

9 *https://www.theatlantic.com/education/archive/2017/08/the-real-legacy-of-crazy-horse/534924/*

10 *https://www.re-member.org/pine-ridge-reservation*

11 *Indigenous Physicists: https://indigenousphysicists.com/*

12 *APS Gazette Fall 2020: The APS gazette in the fall published a very insightful article about being indigenous: https://www.aps.org/programs/women/reports/gazette/upload/fall20-rev.pdf*

13 *https://www.aps.org/programs/minorities/bridge/index.cfm*

14 *https://aps.org/programs/minorities/nmc/*

15 *https://www.aises.org/*

16 *Mentor Resource Library https://www.aps.org/programs/minorities/nmc/webinars.cfm*

17 *https://science.osti.gov/-/media/grants/pdf/foas/2021/DE-FOA-0002456.pdf*

Funds for Black/African, Latinx, and Indigenous Students *(continued from page 4)*

program (TUTSP)[6] is being administered by the Society of Physics Students (SPS) and is an integral part of TEAM-UP program which has the goal of doubling the number of Black bachelor's degree earners in physics and astronomy by 2030. The full TEAMUP report can be found here[7]. Students with a 2.0, or higher, GPA can apply for awards of up to $10,000 once per academic year. Successful applicants can use these funds to help cover tuition and fees required for enrollment or attendance at the educational institution, or for other fees, books, supplies, and equipment required for courses at the educational institution.

Since 2022 was its pilot phase applications were limited African American students in the pursuit of their bachelor's degrees in physics at Historically Black Colleges and Universities (HBCUs) and Predominantly Black Institutions (PBIs), and African American astronomy undergraduates at all accredited higher education institutions. It is planned that these scholarships will be steadily opened to African American physics students at all institutions.

For 2022 only TU-T will accept applications on a rolling basis until funding is expended with the following deadlines (applicants notified): October 10 (October 24), November 15 (November 29).

Applications are simple, along with details of your studies to date, you will need to submit a written statement indicating why you are pursuing your degree and how the funds will help support your continued education and a letter of recommendation.

Endnotes

1 *marginalization – ignoring or pushing a person's or group's experiences to the periphery of a larger group or society.*

2 *minoritization - (of a group) being grouped into a smaller number than another (or other groups) as a result of the application of policies or practices of people in the majority group. For example, being a racial minority in a region due to immigration policies that do not allow (or limit) people of a certain racial group immigrating into the region.*

3 *https://aps.org/publications/apsnews/202101/impact.cfm*

4 *https://aps.org/programs/minorities/nmc/*

5 *https://aps.org/programs/minorities/nmc/nmcbeam.cfm*

6 *https://www.spsnational.org/scholarships/teamup*

7 *https://www.aip.org/sites/default/files/aipcorp/files/teamup-full-report.pdf*

Human Experience in STEM *(continued from page 2)*

dence based and locally applicable. No doubt this flexible and effective structure for community engagement is the reason the HSTEM course has flourished and spread to many universities.

When you peek into our classroom, it's clear that our learning community is a supportive refuge for marginalized students. For them, coming to class feels like a deep exhale as students are comfortable bringing their full humanity, including all of its identities, imperfections and experiences that make them question if they belong in science. Here, finally, is a place where their complex identities do not feel in conflict with their scientist identity. With our project work, we try to bring that same feeling to other STEM classrooms and labs. Working locally, in parallel with multiple sites across the Being Human in STEM Network, we hope to expand and replicate these pockets of refuge across the wider landscape of all humans doing science.

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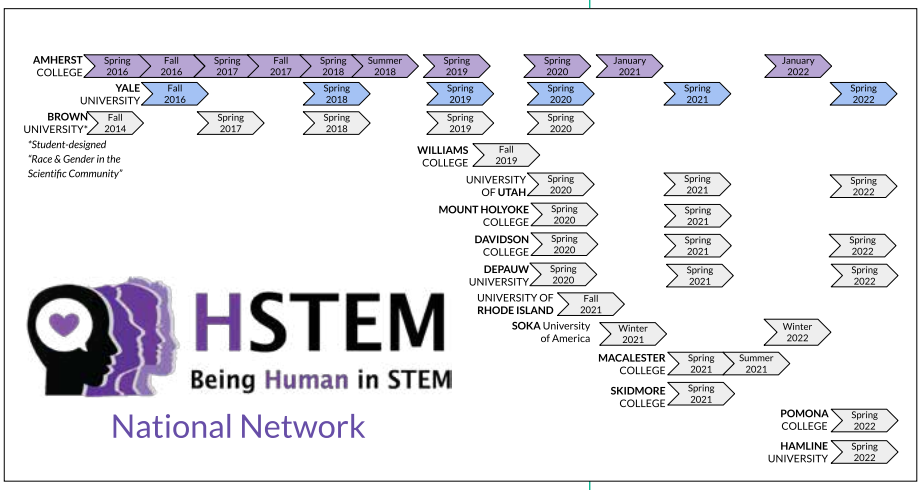

The expanding Being Human in STEM National Network. Each arrow indicates an HSTEM course offering.

Endnotes

1 *http://www.beinghumaninstem.com/, https://csme.utah.edu/beinghumaninstem/*

2 *Bunnell, S., Lyster, M., Greenland, K., Mayer, G., Gardner, K., Leise, T., Kristensen, T., Ryan, E. D., Ampiah-Bonney, R., & Jaswal, S. S. (2021). From protest to progress through partnership with students: Being Human in STEM (HSTEM). International Journal for Students As Partners, 5(1), 26-56.*

3 *Jaswal, S. S. (2022). Lessons from a quarter century of being human in protein science. Protein Science, 31(4), 768-783.*

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Questions? Comments?
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Request to join the
APS Minorities in Physics Facebook group
www.facebook.com/groups/APSMinorities.