APS physics | National Mentoring Community

Conversations

NEWSLETTER OF THE APS NATIONAL MENTORING COMMUNITY

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2016 CONFERENCE

Join us for the Annual National Mentoring Community Conference in Houston, Texas

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APS National Mentoring Community & Bridge Program Conference participants at Florida International University

New APS Mentoring Program Aimed at Increasing Underrepresented Minorities in Physics

THEODORE HODAPP *APS Director of Education & Diversity*

For decades, the American Physical Society (APS) has invested resources to increase the participation of underrepresented minorities (URMs) at the undergraduate level, and more recently, with a program aimed at the PhD level in physics. The latter project has been successful at enacting changes that will effectively close the gap between undergraduate and graduate degrees earned by URM students. The logical next step is: How do we raise the fraction of URM bachelor's degrees from the ~10% awarded now to something closer to the fraction of students from these groups that comprise the general population?

The APS Committee on Minorities considered possible actions over the past several years and after a number of studies and substantial deliberation recently launched the National Mentoring Community (NMC). Now in its first year, the goal of the project is to significantly increase the number of African American, Hispanic American, and Native American students who earn bachelor's degrees in physics.

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Attendees Weigh in on the First Annual National Mentoring Community Conference

ARLENE MODESTE KNOWLES *APS Diversity Programs Administrator*
AND SUSAN SARGENT *APS Education & Diversity Programs Coordinator*

NMC Conference attendees work in groups to provide feedback to APS staff on shaping the program

l. to r. - 1st Place Graduate Poster Prize winner, Olga Harrington, USF, and APS Committee on Minorities chair, Prof. Nadya Mason, UIUC

The first annual conference of the National Mentoring Community took place at Florida International University in Miami, Florida, October 9-11, 2015 and was held in conjunction with the APS Bridge Program annual meeting. Pairing these two conferences was meant to create an ideal experience for undergraduate and graduate students to learn from and support one another, while faculty and administrators had the opportunity to network with each other, listen to the needs of their students, and learn how to support them. Following the conference, we asked attendees to evaluate everything from the venue and location to the conference program, and we learned what went well and what could be improved. We also gathered some demographic information on our participants.

Like FIU, but unlike most "physics" conferences, the NMC/Bridge Program Conference itself was quite diverse. Roughly half of the nearly 180 attendees were students, and one-quarter were women (cis- and trans-). Not surprisingly, given the large percentage of Hispanics enrolled at FIU and within their physics department, a significant number (41%) of the conference attendees were Hispanic. Twenty-six percent (26%) of the attendees were black, 26% were white, and 6% were Asian.

> "I attended to build a better relationship with my mentor and learn about mentoring. Yes, my objectives were met."

Participants had a number of important goals for attending the NMC Conference that included: understanding and building better mentor/mentee relationships; learning about career options and best practices within the NMC and Bridge Programs; gaining a better sense of the challenges around diversity in physics; having an opportunity to network, professionally develop, and present their research; and getting a glimpse into specific university programs. Nearly all attendees said that the conference met and/or exceeded their goals.

The conference featured plenary talks ranging from mentoring and admissions research to powerful, personal accounts of mentoring students and being mentored to explanations of sociological constructs like Stereotype Threat, Imposter Syndrome, and Growth Mindset, all of which can have profound effects on mentoring relationships. One of the standout plenaries was that of Professor Mary James of Reed College, who gave a talk on "What Access Really Means" (with

> "Mary James' talk was fantastic!"
>
> "Mary's talk was super awesome, and should be a TED talk."
>
> "The plenary lectures were among the best I've seen at any conference. Mary James was particularly compelling. There was a good amount of informal time in which to chat with people."
>
> *— NMC Conference Attendees*

"Great talk! It brought to light scientific findings that revolve around stereotype threat and bias in academic culture."

(In reference to Dr. Joseph Brown's talk, "Increasing Diversity by Changing the Culture of the Academy")

respect to mentoring students in college). Her talk was interwoven with her personal story of how her mentors provided access to opportunities and skillfully guided her along her educational path, and how she, in turn, provides access to her students.

The most valued outcome for many attendees was the opportunity to network with a broad spectrum of people, whether informally through introductions by peers and mentors, or as part of facilitated discussions. Additionally, many cited specific plenaries and the information presented in various sessions as some of the most valued elements. For some, learning about how diversity plays a role in institutional processes, whether overtly or as part of larger social inequalities was incredibly useful. Other highlights included: mentor training, the poster session, career information, and informal time to mingle.

Overall, there was considerable enthusiasm about the material presented at the conference and many respondents were excited about developing and enhancing mentor programs at their own institutions through activities such as mentoring workshops, building peer mentoring programs, and affirmation exercises for new students. Many participants expressed an interest in their institutions becoming Bridge sites - having just learned about the program - and some mentioned the oversight and training of mentors as being important considerations for their programs in the future.

New ideas that were of interest to conference respondents included: departmental tea time, workshops on mentoring for post-doctoral researchers and faculty members, holistic evaluation of admission applications, active teaching and learning, outreach to high schools, and time management training for mentees.

As far as location goes, it seems Florida International University was an ideal venue for the APS NMC/Bridge Program Conference. In addition to being in Miami, Florida, a warm and culturally diverse part of the U.S., the campus facilities added to the success of the conference. Attendees were impressed with the physics education research-inspired SCALE-UP classroom that served as the main meeting room. The table groupings allowed participants to more easily interact and have in-depth discussions with one another. The additional meeting (class) rooms, audiovisual amenities, and general accommodations were also appreciated by the participants, who called them "splendid", "fantastic", and "great!" Finally, there were rave reviews regarding the quality and quantity of food, another perk from being in a place like Miami. ■

"I liked how this activity helped me get to know others at my table, who were undergrads. It was very important that you helped us sit at mixed tables."

— *Participant in the "Role of Graduate Students and Postdocs in Mentoring Discussion"*

Prof. Mary James, Reed College (middle) with NMC Mentees, Grayson Perez (left), and Elizabeth Arellano (right)

Prof. Julie Posselt during her talk, "Graduate Admissions: Merit, Diversity and Faculty Gatekeeping"

NMC Mentor – Mentee Spotlight

ARLENE MODESTE KNOWLES *APS Diversity Programs Administrator*

Oscar Castro (left), NMC Mentee, physics major, St. Mary's University of Minnesota with Prof. Demian Cho *(right), NMC Mentor, physics professor, St. Mary's University of Minnesota*

When we first developed the National Mentoring Community, we envisioned building a network of physics faculty mentors able to guide their student mentees down the educational path by opening doors, providing resources, advising them, and caring about their success, defined ultimately by the students obtaining physics degrees. What we found, when we met many of our NMC Mentors at the first National Mentoring Community Conference, were faculty mentors who did all of these things, but wanted to do much more. The NMC mentors that we met are concerned about equity in physics, are interested in learning how they can better support their mentees holistically, are concerned with being culturally competent, and genuinely care about their student mentees as people. They are committed to mentoring these students, who will become the next generation of physics-trained professionals and physicists to solve some of society's most complex problems.

One NMC Mentor-Mentee pair that stood out to many at the NMC Conference was Professor Demian Cho and Oscar Castro, who seemed to embody the spirit of the program and the beginning of a productive mentor-mentee relationship. I spoke with them for several minutes at the Conference and was struck at how committed and easy their relationship seemed to be. This was especially surprising since they only formed their mentor-mentee relationship through the APS NMC Program a few months earlier.

We asked Dr. Cho and Oscar to share their thoughts about the mentoring relationship they've established and the NMC Program thus far. Below, you will find their thoughtful responses to our questions.

> It is important to note that each mentor-mentee pair will build their own unique relationship. Some will be more personal and informal in nature, while others will be more professional and formal. The NMC Program endorses specific mentoring activities between mentors and mentees and asks that mentors care about and be committed to the individual success of their mentee/s, but the NMC Program does not specify the nature of the mentoring relationships.

NMC MENTOR

Prof. Demian (Hyun Jai) Cho

St. Mary's University of Minnesota

NMC Program: Why did you consider joining the NMC Program, and what benefit did you think you'd receive?

Dr. Demian Cho: I myself am ethnically a minority (Eastern Asian), therefore I always assumed I knew about being a minority. But, after I taught a few minority students in my past classes, I realize that I wasn't really prepared to guide minority students. When Oscar became my advisee he was the first minority student in the department for a long time. I thought to myself, it's time for me to understand a bit more about mentoring minority students. Our campus has minority supporting programs, but when I saw an ad about the NMC program, I grabbed an opportunity. I guess what I wanted from the NMC is more physics-specific advising. In the past I went to several workshops on teaching, but as the APS new faculty workshop was so helpful and specifically designed for physics faculty, I thought the NMC would be a similar venue to give me a specific, well-designed, experience and research-based program.

NMC Program: How did you identify and pair up with Oscar?

Cho: Saint Mary's is a small school (3 faculty department). I taught him both intro physics sequences and modern physics, so I guess I am a natural choice. I also remember meeting Oscar and his mother when they visited the campus before choosing to attend Saint Mary's, so I feel little bit more responsible.

NMC Program: How did you structure your relationship?

Cho: Being a small department, I think, we have very close relationships between faculty members and students in general. I am trying to maintain a very casual and informal relationship with students. My relationship with Oscar is similar.

NMC Program: Did you have face to face meetings initially? How was your first meeting and subsequent meetings?

Cho: Because he is my advisee we already had advising meetings. I also meet him at least three times a week because of classes, so we didn't have NMC specific meetings yet, but NMC made me think about things I never really considered important before. I think that was the

main take-away message from the NMC meeting for me.

NMC Program: What benefits do you think you are getting now that you are in this mentor/mentee relationship?
Cho: First of all, I want to emphasize that the benefits are mutual. As much as Oscar is benefitting (hopefully) from this relationship, I also really appreciate his openness and trust. Like in any human relationship, it broadens one's perspectives on various human conditions that you didn't know before.

NMC Program: What are the challenges, if any?
Cho: Time is the biggest issue.

NMC Program: What advice would you give to mentors or mentees?
Cho: As in any relationship, the most basic ingredient is trust. Also, it is very important to have respect for the other person's perspective. The very first (and perhaps the most important) lesson I learned in the APS [AAPT] New Faculty Workshop was "They (students) are not you!" I think that lesson is even more important here because mentoring minority students involves not only academic issues, but also cultural issues. Mentors should be very open-minded about various situations. In many situations, students just need a trusting person who can listen to them and sometimes suggest possible solutions. For mentees, be proactive. Many faculty members are ready to and want to guide you. Just come, open-up, and build your relationship with mentors. They are not that scary.

NMC Program: What do you think about the NMC program and prompts?
Cho: I think that the program is excellent. I highly recommend anyone, even the ones who think they know how to mentor minorities (I thought I did), to join and be active. STEM and physics needs more minority students.

NMC Program: Is there anything else you'd like to add?
Cho: I consider STEM education as a social justice issue, therefore recruiting and mentoring minority students has larger social implications. My past experience taught me that many minority students are struggling academically due to the lack of a social anchoring point. Most campuses have some kind of minority support system, but they are usually more on social issues. Trained and motivated mentors can provide both a social anchoring point and an academic guiding light.

I also want to encourage more participation from non-minority faculty. I know there are interests, but many of them either think they know how to be good mentors (not!), or think it is very difficult for them. I think that programs like NMC can really help them.

NMC MENTEE

Oscar Castro

2nd year physics major, St. Mary's University

NMC Program: Why did you consider joining the NMC Program, and what benefit did you think you'd receive?
Oscar Castro: I have always believed in the importance of and great influence that can come from mentoring. I was also excited to meet the many other professors and students who were going to be a part of the program. I was interested in exchanging experiences and gaining a bit of wisdom from the more experienced physicists.

NMC Program: How did you identify and pair up with Dr. Cho?
Castro: Dr. Cho humbly asked me if I had received an email from APS and walked me through the process of applying to the NMC. It was not until attending the conference that I realized that the invitation had actually come from him and that if it was not for him choosing me, I would not have the chance of being a part of this appreciated and inspiring program.

NMC Program: How did you structure your relationship?
Castro: Dr. Cho and I have had a running relationship since the start of my first physics class in college. So far, he has been my professor for all of my physics classes. In addition to simply being an instructor, he took care and concern from the very start about my journey through the world of physics.

NMC Program: How was your first meeting and subsequent meetings?
Castro: Being that Dr. Cho and I had already established a good relationship, he simply approached me during one of my labs and told me about the opportunity. We then set up a more formal meeting to talk about the conference. The first meeting was just a ball of excitement! The excitement and eagerness grew as the meetings went on, and I began to envision the endless possibilities that would come from it [the program]. As for how the meetings went between

Prof. Demian Cho (left) and Oscar Castro (center) chat with Arlene Modeste Knowles (right)

Dr. Cho and me, he was always looking for the best in his students and I came in with an open mind, so the meetings tended to flow nicely.

NMC Program: What benefits do think you are getting now that you are in this mentor/mentee relationship?

Castro: The most important benefit that comes from having a mentor is the support. Sometimes believing in yourself just does not cut it, and it is not until someone else sees the great[ness] from within you that you can fully begin to perform. The constant check-ins and accountability from my mentor keeps me on the right path and keeps my eye on the prize. It is knowing that there is someone [there, and] your hard work is now being accounted for that gives you the extra fuel to go. The resources that come from meeting other mentors and mentees, as well as the ones that the APS and my mentor provide, are also a significant part of this journey.

NMC Program: What are the challenges, if any?

Castro: Making the transition from a predominantly Hispanic high school, to a college of mostly white students has been an interesting challenge. Traveling so far out of state, I had always looked forward to immersing myself in the diversity that I would find myself in within the college environment. This is not the case for my current school, but I am growing from the experience of actually feeling like a minority. With this, of course, comes many new challenges such as a natural decline of confidence and even a bit of awkwardness between students who are not used to interacting with people with such different backgrounds.

In terms of the difficulties that come from the mentor pairing, [there may be difficulties understanding one another due to our different backgrounds]. For instance, my mentor is from Korea and although I am from the United States, my family comes from Mexico. Additionally, I will be the first in my family to graduate from a four-year university or a college at all. My mentor on the other hand, comes from a family of doctorates, where receiving the highest level of education is the norm. These are examples of simple things that separate us, but just like any relationship, I am sure that these will be the certain qualities that will feed our relationship and allow us to grow with one another.

NMC Program: What advice would you give to mentors or mentees?

Castro: Consistency is key. Although it may be easy to get wrapped up in our fast paced and high demanding lives, it is important to always have a time set aside for meetings or just check-ins with one another. Also, it is important to keep an open mind, whether that be about a certain situation a student may be going through or the advice that a mentor has to offer. This is crucial in sustaining a healthy relationship.

NMC Program: Is there anything else you'd like to add?

Castro: [In this interview] I decided to emphasize the challenges that I face so that others may have something to relate to. Also, I have learned that there is always room for improvement, and with nothing to work for, there is no progress to be made. ■

New APS Mentoring Program Aimed at Increasing Underrepresented Minorities in Physics

continued from cover

The main thrusts of the project include motivating faculty to engage students at their university to develop mentor-mentee relationships; providing regular prompts and other information (like this newsletter) to help students and faculty understand how to improve these relationships; and a national conference that brings together mentors, mentees, and leaders in mentoring to share experiences, scholarship, and strategies that help us all act thoughtfully and proactively to address the significant lack of diversity in physics.

The project has already held its first meeting with more than 175 participants this past October in Miami, FL, and is planning the next event for 21-23 October 2016 in Houston, TX. This event will focus on the role of undergraduate research in promoting success at the baccalaureate level and include tours of NASA facilities and interactions with nearly every Physics REU site leader.

Beyond this, the APS Committee on Minorities is planning to bring increased resources that will build on these initial successes. Next steps include developing awards and recognition for mentoring – an activity that is not commonly recognized or rewarded in academia. APS is also planning on raising funds to provide need-based scholarships that NMC mentors can request in specific cases where a small amount of explicitly targeted funds could make the difference between completing a degree and dropping out of physics for their mentee.

All of this is made possible through APS funds and through generous private donations to the APS on behalf of improving diversity in the discipline. The success of this program depends on receiving feedback from faculty, students, and donors that will help us pinpoint critical needs and interventions that the American Physical Society can take to improve the fate of underrepresented minority students in physics. Let us know what we can do to take the best next steps. ■

Proudness: What Is It? Why Is It Important? And How Do We Design for It in College Physics and Astronomy Education?

ANGELA LITTLE *Researcher, Michigan State University*

Dr. Angela Little, MSU

This article is adapted from my article in "Status," the newsletter of the Committee on the Status of Women in Astronomy (CSWA) (June 2015, p.7-14). I'll begin with describing some motivation for proudness as an idea and end with concrete discussion questions for use with mentor-mentee pairs.

Transitions are tough on students, especially big transitions like the one between high school and college. One big reason why this transition in particular can be tough, is that students from a wide variety of high school preparations are often thrown together into large introductory STEM courses. In these courses, it's easy to mistake background for innate ability, and students often compare themselves to their classmates through grades and their relative speed on homework and exams. These comparisons can heavily influence students' decision to major in, for example, computer science [1] and most likely have similar effects on students majoring in STEM in general. This tendency to mistake background for ability is likely amplified in courses and majors in physics, math, and computer science, where students face additional U.S. cultural narratives around the need for inherent "genius" ability: either you're a math person or you're not [2]. Researchers have also shown that such genius narratives particularly affect African Americans and women from all racial backgrounds due to U.S. stereotypes about these groups[1] [2], [3], [4], [5].

Instructors and mentors can play a critical role in either pushing back on these "genius" narratives or amplifying them further. It is key to point out to students that they might be coming from different backgrounds than their peers. Instructors and mentors can also teach students the holistic set of skills important to succeeding in science and college more generally, and support them in learning how to give effective self- and peer-feedback to improve their work. Without this critical awareness, it is no wonder that some students frame struggle as something inherent to failures in their own brains.

I'm one of the co-founders of The Compass Project [6], an APS-award winning program at the University of California, Berkeley that supports undergraduate physical science majors, particularly from marginalized backgrounds. Compass builds an encouraging community, engages students in physics projects, and has a special focus on being reflective about the learning process.

In my work with Compass, I saw many students struggle with self-doubt in their introductory physics courses, and our team asked, "What would it look like for students to have additional information, beyond comparison with other introductory physics students, in deciding whether to major in physics and astronomy? How might it influence students' decisions on a major if they were also engaged in a challenging project of interest to them in which they could acknowledge their strengths and weaknesses, be supported to grow and improve, and feel really good about the outcome?"

Proudness: What is It?

It turns out that the way people use the word proud isn't incredibly precise. For about two years, I've been leading workshops for STEM educators who want to design curriculum that is most likely to result in their students feeling proud. Although I've talked to people who associate the word pride with a negative form of bragging, the idea that we're trying to explore with proudness is the good feeling associated with persisting in and accomplishing something difficult. In the workshops, I introduce the word "proudness" to imply that this is an idea we need to define for ourselves. Together, participants and I try to understand proudness by sharing examples of what we're personally proud of and naming similarities and differences across examples. After hearing over 100 examples from my workshop participants, it's clear that there is an incredible variety of experiences along with a number of

[1] The study by Leslie et al. [2] about genius narratives provided data only on African Americans and women from all racial and ethnic backgrounds. It is likely that other groups would be similarly affected, as additional stereotype threat research has found effects on other marginalized groups.

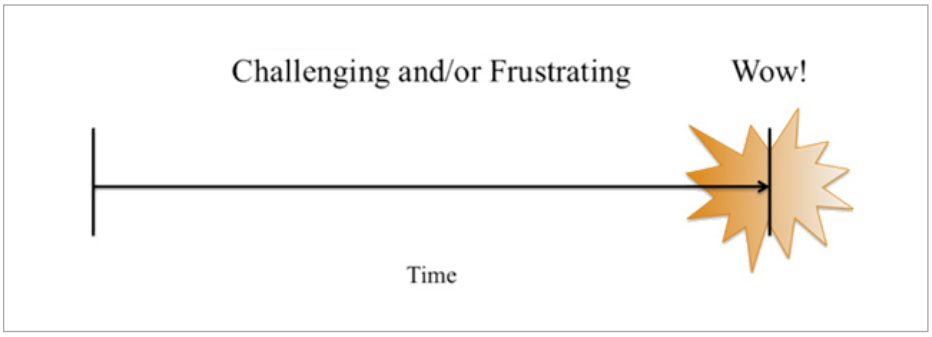

Figure 1: The proudness diagram

common, core features. The following undergraduate student quote, drawn from a research paper on trajectories of successful women of color in science, is representative of many of the proudness examples shared in my workshops [7]. In this quote, a student describes her positive experience with biology research: "I like working in the lab because…you have no idea what you're doing…and so you do a lot of stuff…and then you find out that it works, and you're just kind of like, 'Wow, I did that, and it works!'" At the core of these kinds of experiences is a time where an activity is frustrating, challenging, unclear and/or repetitive. Eventually there is a "Wow!" moment that could involve a breakthrough or a good feeling of accomplishment, as in Figure 1. Athletic activities and teaching were other common sources of proud moments.

The simple proudness diagram invites questions like, "What might allow us to amplify the Wow! moment at the end? What kind of factors might dampen the Wow! moment? What is the time scale?"

The diagram gives a sense of the basic structure of proudness. Over the years, workshop participants and I have also identified six common themes that arise most often across examples. Taken together, these themes can act as a guide for mentors and instructors who want to make sure their students have positive experiences in science.

Six Common Themes of Proudness

Ownership - Work that one feels personally responsible for and invested in

Improvement - Work that is iteratively improved over long time scales

Feedback - Constructive feedback by colleagues

Challenge - Work that is outside one's comfort zone

Communicability - Work that is shared publicly and positively engaged with

Tangibility - Work that culminates in something concrete, e.g., a talk, a poster, a work of art, or a computer program

Proudness: Connection to the Broader STEM Education Literature

The ideas around proudness are not new. What I find so compelling about proudness is that it acts as an umbrella, bringing together many ideas that we know to be important. There are many potential connections to make between the six proudness strands and the areas of research in the STEM education literature. For instance, the *Tangibility* and *Communicability* strands are related to Papert and colleagues' theory of constructionism, which asserts that learning happens especially well "in a context where the learner is consciously engaged in constructing a public entity" [8]. The *Communicability* strand connects to Carlone and Johnson's work on science identity and the importance of competence, performance, and recognition [7]. The *Improvement* strand connects to Dweck and colleagues' work on growth mindset and the importance of believing that one can improve [9],[10]. Further, many more connections can be made. For example, see the box on Growth Mindset

Proudness: How Do We Design For It?

In an ideal world, I would want all students to take on a Proudness Project every year of their university experience. It is important to create room in the structure of the university for students to take on projects of interest, whether through offering course credit,[2] engaging students in research as early as possible,[3] bringing open-ended problems into introductory physics courses,[4] or supporting students' volunteer or outreach efforts. While there is clearly work still to be done in creating this room, how might a mentor or research advisor apply ideas from proudness to advising their current students?

Toward Building a Growth Mindset: Feedback and Improvement on Something Tangible

Before students can see their improvement, they need something tangible to be able to see their improvement on. Consider the kinds of homework sets that are given in most traditional college science courses: how often are students asked to return to a problem and im-

[2] This is the approach we've taken in The Compass Project. [15]
[3] Some NSF S-STEM programs provide tuition stipends to students and engage them in research during their first year.
[4] See, for example, Dan Reinholz's [16] work on bringing one open-ended problem into the weekly homework in traditional introductory college math and physics college courses and supporting students in giving peer feedback.

Growth Mindset & Proudness Projects: Implications for STEM Learning

ANGELA LITTLE *Researcher, Michigan State University*

The concept of growth mindset comes out of nearly 40 years of psychology research by Carol Dweck and her colleagues. On her Mindset website [11], Dweck defines both a fixed and a growth mindset:

"People with a fixed mindset believe that their traits are just givens. They have a certain amount of brains and talent and nothing can change that. If they have a lot, they're all set, but if they don't . . . So people in this mindset worry about their traits and how adequate they are. They have something to prove to themselves and others."

and

"People with a growth mindset, on the other hand, see their qualities as things that can be developed through their dedication and effort. Sure they're happy if they're brainy or talented, but that's just the starting point. They understand that no one has ever accomplished great things . . . without years of passionate practice and learning."

One can have different mindsets in different contexts. For instance, someone might have a fixed mindset about art, but a growth mindset about biology or even just certain sub-areas of biology. It's a simple yet powerful idea: your beliefs about your ability to learn and grow impact the learning process. The idea of growth mindset has been shown to be critical for both students and instructors in STEM learning in particular. Research has shown that, for students, having a growth mindset influences decisions to major in computer science [1]. Whether college math learning environments send a fixed or growth mindset message to students has been shown to have a negative or a positive impact on female math majors' sense of belonging [12]. Faculty members' fixed mindsets can also lead to their giving harmful "comfort feedback" that deemphasizes the possibility that students can improve [13].

Ideal Proudness Projects, with their goal of providing students with a concrete experience of their own improvement, have the potential to support the development of a growth mindset in college physics. Traditionally, interventions aimed at supporting the development of a growth mindset have focused on the neuroscience of the brain, and how the brain can form new connections. Such interventions, some given online in as little as 30 minutes, have had major impacts on struggling middle school math students and remarkable correlations with college persistence when given to seniors in high school [14]. If 30 minutes of hearing that one can theoretically grow and improve has such an impact, imagine what the direct experience of one's own growth and improvement could do. At Michigan State University, a colleague and I are currently studying whether and how in-depth projects paired with an introductory calculus-based physics course can support students' development of a growth mindset in physics.

prove upon it? This happens infrequently, if ever, in most college courses. This lack of iterative improvement can be limiting for students' ability to see their growth.

What tangible things make sense for undergraduate students to work on improving? For some students, poster presentations may be built into their research or coursework. However, if your mentee is engaged in a more traditional introductory physics course, you could encourage them to start small: create a short blog post on an interesting problem of interest to share with their family members. Ideally, students could pick a problem from their coursework that they find interesting and hard. If no such problems exist as part of students' normal course work, online Fermi Problem caches can be a great resource. Recall the *Communicability* strand of proudness, i.e. work that is shared publicly. For many students, having other people see their poster or blog post can provide both motivation to improve it as well as positive interactions with peers, mentors, colleagues, friends, and family around interesting physics topics.

In assisting students to see their growth, one important strategy is to have a plan in place to save some early drafts of their work. This allows them to return to these drafts at a later time to see how much their understanding has improved.

Mentor/Mentee Discussion Questions:

1. At the end of your classwork or project, will you have created something tangible/concrete that you can share with others (e.g., poster, presentation, art piece, blog post, computer simulation, writing, performance, lesson plan, YouTube video, etc.)? If not, what might a concrete thing look like that would be a culmination of your course or project work?

2. Consider your tangible item. What kind of mentor/peer/family/friend/other feedback and support will you have to complete it? What type of feedback will you receive from each source? Do you think this is a sufficient support network? If not, who is one additional person you will reach out to?
3. Consider your tangible item (e.g. poster, blog post, etc.) How will you save early drafts so that you can return to them later and notice how you've improved? If students struggle to see their improvements, mentors can often help them see things that they may not have noticed.

Supporting Students Through the Time Period Where Work is "Frustrating, Challenging, Unclear, and/or Repetitive"

If students are working on an in-depth research project or college course that might require long periods of frustration before seeing results, helping them to find some way of tracking the time that they put in is important. When I was working on my dissertation research, a colleague recommended tracking the time I spent in 45-minute increments with gold stars (Fig. 2) in a day planner. The stars provided two critical pieces of insight for me: (1) I could see how many hours were required before I would make a research breakthrough. I could then develop resiliency for hitting a research wall, knowing that I would eventually be able to push through it. (2) I could also make note of time periods with fewer stars and realize that they were causally tied to events important for me to develop self-awareness around. For instance, the stress associated with cross-country travel to conferences often led to an interval showing fewer stars after I returned. The result of this measure gave me a tool for more effectively planning around travel if I had a deadline coming up. Once I finished my Ph.D., it also felt good to leaf through the day planner and see all of the gold stars that I'd used to get there.

Figure 2: The star system worked for me. (By Flickr user Pewari CC-BY-NC-SA 2.0)

Jessica Kirkpatrick recently blogged [17] about how her startup company has everyone track and share things that they're proud of every week. Whether you use gold stars or a spreadsheet, tracking can provide insightful data as well as emotional support during times of struggle.

Mentor/Mentee Discussion Questions:

4. What is one thing that you would like to track this month or this semester (e.g. hours on research or homework sets, weekly things that you're proud of/struggling with, etc.). How will you track this? (e.g. spreadsheet? Piece of a paper? Notebook?)

Being Strategic in Improvement: Identifying Important Skills

A big question that students need to address when working on projects and coursework is, "What skills are most critical to develop for being successful?" A number of rubrics measuring general STEM skills have been developed to support students in identifying what skills to work on and in tracking their improvement. For instance, Compass freshman students have used a Guided Reflection Rubric [18] to pick a holistic science skill (e.g., organization or persistence) to evaluate themselves on throughout their first year. Rubric use has been incorporated into Compass' semester-long project-based physics courses as well as their mentoring program. In the semester-long course, for instance, students would journal weekly on one holistic science skill and then brainstorm initial ideas for improving this skill. As an example, one Compass student focused on developing persistence in homework problem solving in her introductory physics course. She asked for help in developing strategies for persistence because she did not want to rely so heavily on online solutions to problems when she hit a wall. Students' journaled responses then received concrete weekly feedback on how to move forward from a graduate student instructor.

See the references at the end of this article for more information on holistic STEM skill rubric development and implementation [19-21] as well as rubrics associated with more specific experimental measurement and modeling

skills [22].

Mentor/Mentee Discussion Questions

It can also be helpful for mentors to answer some of these same questions and share their own process with their mentees. Through hearing about mentors' struggles, students can realize that even mentors are still growing and working on a lot of things.

5. What is one skill that you hope to develop over the course of your project or class (e.g. organization, time management, collaboration with others)? How will you tell whether you have improved this skill?
6. Are there any explicit reflection activities for the end of your project or class to assess the ways that you have grown, improved, and/or accomplished your goals? Please describe. If there are no such reflection activities, what is one activity that you could engage in with your mentor?
7. Assuming that you have a tangible creation at the end of your project or class (e.g., a blog, poster, art project, lesson plan, etc.), what is one way in which you would like the final draft to be better than your initial draft? How will you be able to tell that it is better?

I encourage you to treat the mentor-mentee questions outlined in this article as a starting point and adapt them in whatever ways make sense based on your own context. Many strategies take time to experiment with before finding the right approach.

Conclusion

By means of self-assessment, students can push back on the traditional introductory physics experience of comparing themselves with others. I'm not arguing that we should never compare ourselves to others; we often identify skills that we would like to improve through admiring those skills in others. Our peers can push us to do better. The goal here is that students, rather than judging themselves harshly on their preparation, identify and pay attention to some skills and tangible things that they care about improving and then work on tracking improvement. In this way, we can mentor students into seeing themselves as capable scientists, participants in a scientific community that supports them to be proud of the work they accomplish. ■

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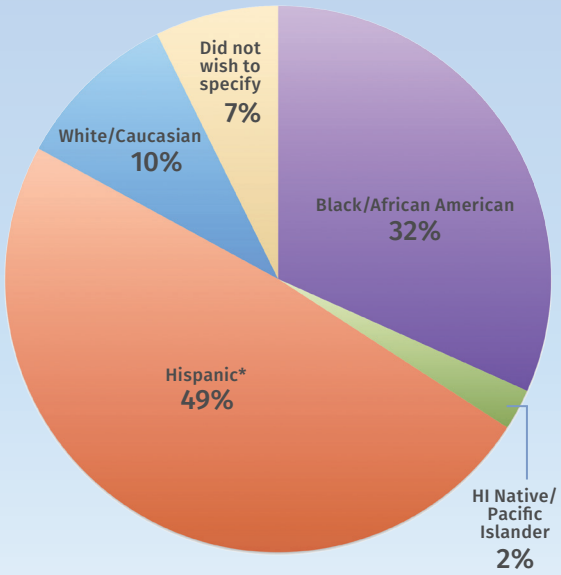

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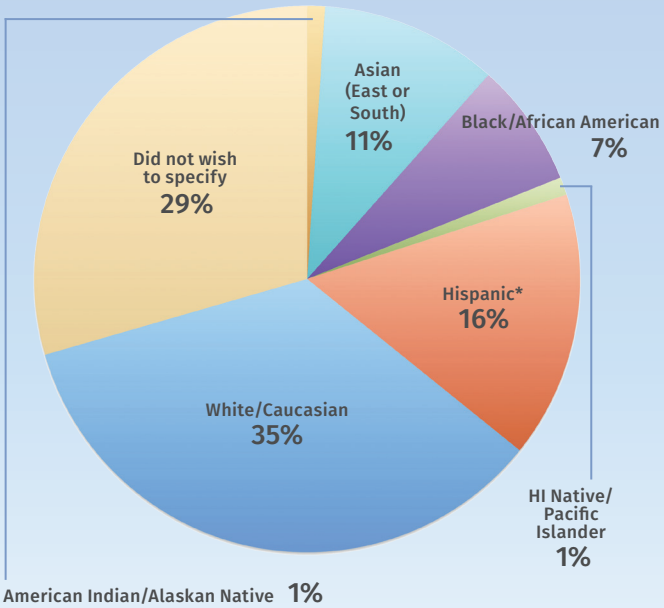

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