Forum on Education
American Physical Society

Summer 2018 Newsletter

Richard Steinberg, Editor

In This Issue:

From the Chair

Larry Cain, Davidson College

As the new chair of the Forum on Education, I would like to bring you up to date on many items relating to the activities of the Forum. The revised bylaws were approved overwhelmingly earlier in the year. Two major changes were a change in the terms of office for Executive Committee members and the addition of a graduate student member-at-large to the Executive Committee. Starting on January 1, 2019, all Executive Committee members will serve for the calendar year, rather than between Executive Committee meetings. Thus, this year's terms for members of the Executive Committee will be shorter and will last until the end of December. This has the impact that three members of the Executive Committee rotated off at the April meeting as in the past, and three more will rotate off at the end of December.

I would like to thank Tim Stelzer, the outgoing past chair for his tremendous work for the Forum during his four years in the chair line. Thanks also go to Geraldine Cochran and Andrew Heckler for their outstanding work as members-at large for the last three years. All three of these will be missed and I wish them well in their future work for physics education.

We welcome three new members to the Executive Committee: Jerry Feldman as Vice-Chair, Eleanor Close as APS-AAPT Member-at-Large, and MacKenzie Stetzer as Member-at-Large.

As the new Vice-Chair, Jerry Feldman has already formed the Nominating Committee to solicit nominations for new Executive Committee members who will take office next January. Please see his call for nominations below. Since this is the first time that we will elect a graduate student to the Executive Committee, I issue a special request for graduate student nominations. This is a two-year position and the student should have at least one and (preferably) two years left until their planned graduation. The student receives travel support to attend the FEd Executive Committee meeting at the April APS meeting. Please send your nominations to Jerry (feldman@gwu.edu).

The March and April meetings this year were very successful. The Forum presents a variety of invited sessions at these meetings – four at the March meeting and five at the April meeting. These sessions cover a variety of educational topics. Chair-elect Laurie McNeil is the FEd program chair this year. She welcomes your suggestions for sessions for the March meeting, 2019 in Boston and the April meeting, 2019 in Denver. Please see her call for suggested sessions below Jerry's article (mcneil@physics.unc.edu).

The Forum also works with the APS Office of Education and Diversity, the Committee on Minorities (COM), and the Committee on the Status of Women in Physics (CSWP) to host the Education and Diversity Receptions at both the March and April meetings. Attendance was excellent at both receptions this year, where APS members working for improved education and diversity met to gather and celebrate the year's successes.

Although it is now past the deadline for submitting nominations for APS Fellowships and Awards for the current year, I want to encourage you to think about nominating persons (or groups) for the APS education-related awards and for APS Forum on Education Fellowship for next year. Specifically, please consider the **Excellence in Physics Education Award** - to recognize and honor a team or group of individuals (such as a collaboration) or, exceptionally, a single individual, who have exhibited a sustained commitment to excellence in physics education; the **Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction** - to recognize and honor outstanding achievement in teaching, sustaining (for at least four years), and enhancing an advanced undergraduate laboratory course or courses at US institutions; the **Award for Improving Undergraduate Physics Education** - to recognize physics departments and/or undergraduate-serving programs in physics that support best practices in education at the undergraduate level; and the **APS Forum on Education Fellowships** – to recognize exceptional contributions to the physics enterprise; e.g., outstanding physics research, important applications of physics, leadership in or service to physics, or significant contributions to physics education. Fellowship is a distinct honor signifying recognition by one's professional peers. We all know of deserving colleagues for these awards and for fellowship, but we must nominate them for them to be considered.

You recently received an APS message from me concerning a bill before Congress called the PROSPER Act. This message was sent by FEd on behalf of the APS Office of Government Affairs (OPA) because of the bill's impact on physics education – specifically, student loan debt and limiting graduate student loan opportunities and amounts. FEd will continue to partner with OPA when that partnership fulfills FEd's purpose to involve its members in activities related to physics education, at all educational stages, from elementary to grad school and life-long learning.

FEd also works closely with the APS Committee on Education (COE). The past chair, chair and chair-elect of FEd are also members of the COE. In this way, the Forum maintains an active voice in physics education in the American Physical Society.

We can be successful only by having an engaged membership in the Forum. Please contact me or any member of the Executive Committee with suggestions or contributions toward our educational mission.

Call for Nominations for FEd Executive Committee

Jerry Feldman, George Washington University

Greetings to all of you! Yes, once again it is time to elect new members to the Executive Committee of the Forum on Education (FEd). There is a slight change to the procedure this year we will also be nominating the first **graduate student member** of the Executive Committee. As in past years, we have three Executive Committee positions for which to elect members: Vice Chair (who, in subsequent years, becomes Chair-Elect, Chair, and then Past Chair), one Member-at-Large (3-year term), and one APS/AAPT Member-at-Large (3-year term). But this year, in addition, we have one new slot for a graduate student representative (2-year term). All nominees must be members of the FEd. The APS/AAPT Member-at-Large must also be a member of AAPT.

The FEd Executive Committee plans education-related sessions at APS meetings, nominates new APS Fellows, and presents FEd awards. They represent the goals and concerns of the FEd membership to the APS Council of Representatives. Serving as a FEd officer is also an excellent way to learn about APS and its various educational missions and to influence science education at the national level.

The nominating committee will convene later in the summer to create a list of nominees for each position and assemble a ballot. Please keep in mind that this is an excellent opportunity to promote some of the excellent **graduate students** in our field as possible candidates for the new graduate student representative. New officers of the FEd Executive Committee will begin their service on January 1 of the year following their election.

We appreciate your thoughtful consideration of potential candidates for these FEd Executive Committee positions. Please send suggestions nominating yourself or a colleague to:

Jerry Feldman (feldman@gwu.edu)
FEd Vice Chair and Chair of the Nominating Committee
Department of Physics, George Washington University

Request for Session Topic Ideas for Upcoming APS Meetings

Laurie McNeil, University of North Carolina, Chapel Hill

Each year the Chair-elect of the Forum on Education is also the chair of the FEd Program Committee. The Committee organizes invited sessions at the American Physical Society's March and April meetings. The Forum is allocated a number of invited sessions at each meeting, a number that can be increased by co-sponsoring sessions with other units such as the Forum on Outreach and Engaging the Public (FOEP), the Topical Group on Physics Education Research (GPER), the Forum on Physics and Society (FPS), or one of the scientific Divisions such as the Division of Materials Physics (DMP). One of the March meeting sessions is the **Jonathan Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction** session, at which the award winner will speak accompanied by other related presentations. The other sessions at the March meeting are on education topics chosen by the Program Committee, perhaps in concert with another APS unit. One of the April meeting sessions is the **Excellence in Physics Education Award** session. The Program Committee works with the AAPT to sponsor two April meeting sessions and with GPER to sponsor one April meeting session; there is an additional April session on an education topic chosen by the Program Committee.

We are always looking for ideas for session topics (and potential invited speakers) that would be interesting and beneficial to the members of the American Physical Society whether or not they are members of FEd, since education in physics affects us all. If you have ideas that you think would make good invited session topics at one or the other of these two meetings, please send them to Laurie McNeil (mcneil@physics.unc.edu). Any ideas submitted will be considered by the Program Committee this year, and if not implemented will be passed on to future program committees for their use.

FEd also sponsors contributed sessions at both these meetings at which are presented papers that are contributed in the Physics Education sorting categories. I invite you to consider contributing an education paper to one of these two meetings.

Director's Corner

Theodore Hodapp

GRE – What can it tell you?

A substantial portion of the physics community relies on the Physics Graduate Record Exam (P-GRE) to provide an "unbiased" assessment of a student's preparation for completing a doctoral degree in physics. Unfortunately, the P-GRE is neither unbiased, nor an accurate assessment of a student's chances of completing a degree.[1]

Consider the student who grew up in an inner-city neighborhood, where the high school math teacher had to teach to the lowest common denominator, and where physics wasn't offered because the principal didn't think his students could "handle it."[2] This same student attends a small, public, underfunded 4-year college, where the physics program graduates few students, and many of the upper-division courses are either not offered, or given as "reading courses," where the student has to essentially learn the topic on his or her own. How well will this student fare on the P-GRE? Will the exam be a good indicator of his or her potential to complete a physics PhD? Should we exclude this student from getting a PhD?

What about students who were not told or did not understand how the test would be used to sort their graduate school application? Or, as we have heard from students in the APS Bridge Program, they took the test, and based on their score, decided that physics graduate school was not for them. In cases like these, we are missing the opportunity to provide equitable opportunities for students who have the drive, but perhaps lack some preparation, to join us as our colleagues. If we approach graduate admissions with the thought that we will select the "best and the brightest," by selecting students with high P-GRE scores, we will likely miss the "tenacious and capable"[3] – students who have the desire but may need a little guidance or perhaps a semester of undergraduate E&M to get them ready for graduate studies.

And then there is the issue that some students don't take the GRE-style multiple-choice tests very well (last time I checked, being able to take multiple-choice tests is rarely seen as a measure of excellence in research). Or very well documented issues like stereotype threat, where students of a particular group perform more poorly on high-stakes exams (like the GRE) when they fear they will confirm a stereotype of their group (e.g., poor math or science skills).

The P-GRE *may* be telling you something about a student's pedigree, but very little about their potential. And just by requesting or requiring the exam, you will be telling many students not to apply to your program. Is this the message you want to transmit? The NSF decided it did not want to say this and dropped the GRE requirement for their prestigious graduate research fellowships a number of years ago. A number of prestigious universities have dropped their GRE requirement, and found an increase in the number and diversity of their applicant pool.

If you feel your department cannot stop using it, there are ways to reduce the bias introduced by the exam: (1) don't require it; (2) don't use it as a minimum score (ETS, the makers of the exam, even say this is inappropriate, and yet more than a third of all physics programs still follow this practice[4]); (3) don't show the score to the admissions committee first (this introduces something called "anchoring bias," where a reviewer will rate an application more poorly when a lower score is seen first, than if they were unable to see the score to begin with); (4) educate your admissions committee on the biases inherent in such exams that work against underrepresented groups, and (5) design a set of written guidelines for reviewing applications, and discuss these with the admissions committee – a way of minimizing arbitrary or unintended bias.

Finally, stay tuned for a proposed APS statement on the GRE. The APS Committees on Education, Minorities, and the Status of Women in Physics have recently proposed one for consideration to the Panel on Public Affairs. Let's not waste talent by missing them because of this exam.

(Endnotes)

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2. A. Kelly, K. Sheppard, "Secondary school physics availability in an urban setting: Issues related to academic achievement and course offerings," *American Journal of Physics* **77** p902 (2009)
3. R. E. Scherr, M. Plisch, K. E. Gray, G. Potvin, & T. Hodapp, "Fixed and growth mindsets in physics graduate admissions" *Phys. Rev. Phys. Educ. Res.* **13**, 020133 (2017).
4. G. Potvin, D. Chari, & T. Hodapp, "Investigating approaches to diversity in a national survey of physics doctoral degree programs: T`he graduate admissions landscape" *Phys. Rev. Phys. Educ. Res.* **13**, 020142 (2017).

The American Physical Society Bridge Program

Erika E. A. Brown, American Physical Society, College Park, MD

Over the last six years, the American Physical Society Bridge Program (APS-BP) has had a previously unimagined impact on the physics community. What began as an effort to increase diversity in the physics workforce through erasing the gap in physics BAs and PhDs awarded to groups traditionally underrepresented in physics, has also helped elucidate a number of useful practices for supporting and retaining all graduate students. In the following article, we share resources describing these practices, as well as program successes, and unexpected lessons learned over the life of the project. The success of the program has also encouraged important departmental discussions about diversity and inclusion within physics graduate education. To support these discussions, APS-BP has facilitated several studies which may be helpful for faculty who are thinking about how to admit and retain students of color in their graduate programs. We share two of these studies here: the first on how physics faculty beliefs about their program and their discipline play into admissions decisions, and the second on how admitted bridge students are successfully brought into their graduate department culture.

The APS Bridge Program: Changing the Face of Physics Graduate Education

Erika E. A. Brown, American Physical Society, College Park, MD

In 2008, the APS Board and Council released a joint statement,[1] charging the APS membership with "increasing the numbers of underrepresented minorities in the pipeline, and in all professional ranks, with becoming aware of barriers to implementing this change, and with taking an active role in organizational efforts to bring about this change."

The APS Bridge Program (APS-BP) was born out of this guiding charge. Recognizing the need for a diverse pool of high-quality domestic physicists, the APS worked to bring its unique status within the physics community to bear on the problem. In 2012, APS received a 5 year, $3 million award from the NSF, and began working to increase the number of physics PhDs awarded to underrepresented minorities (URMs: African American, Hispanic American, and Native American).

In 2015, just over 8% of bachelor's degrees in physics were awarded to Hispanic American students,[2] despite Hispanics representing almost 22% of the American college-age population. Similarly, only about 2% of physics bachelor's degrees were awarded to African American candidates (~15% of US college-age population).[3] The picture is even more dismal when one examines numbers for PhDs in physics awarded to these groups, with only 66 PhDs being awarded to URMs each year, on average.

However, these small numbers present a unique opportunity: a small input has the potential to create a huge impact. If we were to increase the numbers of URM doctoral recipients by about 30 each year, we could bring the fraction of PhDs to parity with the number of BS degrees.[4] We also recognized that to increase the number of students who earn PhDs, we would need to identify and share effective practices designed to help their mentors support and retain them throughout their graduate education.

The program targeted URM students who show potential for a career in physics, but for a variety of reasons have been unable to secure admissions to a graduate program through traditional applications. This allows us to reach students who would not be in graduate school without the program, and to be confident that we are truly increasing the numbers of physics graduate students.

Students submit a common graduate application, which we circulate to physics departments that we have determined to be supportive places for URM graduate students. These departments commit to providing a supportive "bridge" experience for these students. Bridge experiences generally last 1-2 years, and are often very similar to a master's level program. Programs help students navigate the transition from undergraduate to graduate studies, with a focus on preparing students for success in a PhD program. Support is tailored to the student's unique needs, and can take the form of additional mentoring, careful progress monitoring, thoughtful induction activities, access to advanced undergraduate and graduate level coursework to fill in knowledge gaps, and more.

The project almost immediately had many more student applications than it could ever hope to place at our (initially) funded bridge sites. So, we developed the concept of Partnership Institutions: physics departments that provide a "bridge-like experience" for students, without financial support from APS. We review applications for new Partnership Institutions semi-annually, and as of this writing, have approved 31 institutions, many of whom have taken bridge students.

To date, we have placed over 150 bridge students (and counting!) into graduate programs across the nation (See Figure 1). In 2017 alone, we were able to place 46 students into graduate programs. Once these students earn a PhD, we will have effectively erased the gap between the fraction of bachelor's and PhD degrees awarded to URMs, a very likely event, since our retention rate is hovering around 85%.

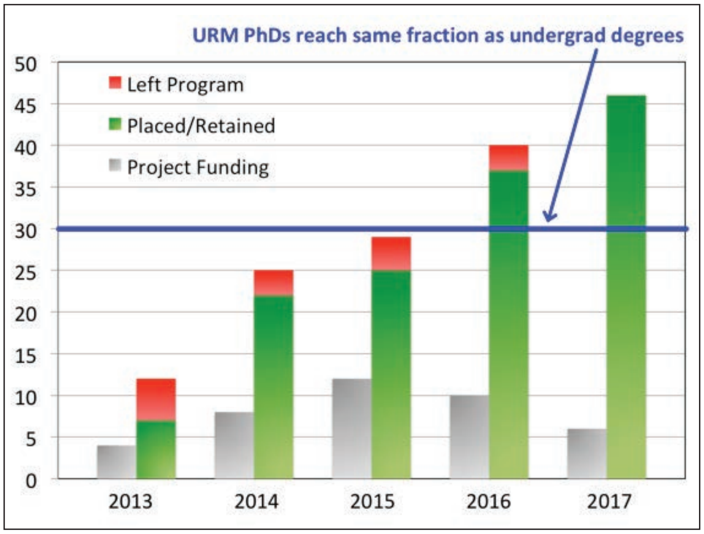

Figure 1: Placement numbers of bridge students over life of the project. Gray bars represent the numbers of students funded by APS, while red and green bars indicate total students placed in a given year. Blue line indicates the number of additional URM doctorates needed to erase the gap between BS and PhD.

Given the program's documented high retention rate,[5,6] we have identified effective practices used to support bridge students. Bridge sites report that these practices are not only effective for retaining bridge students, but also beneficial for all graduate students. We have compiled a number of these practices, and made them available on our website. These include a graduate student induction manual (http://www.apsbridgeprogram.org/resources/manual/) and key components of bridge programs (http://www.apsbridgeprogram.org/institutions/bridge/components/).

There were a few unexpected lessons that we learned along the way. First, we learned that aggregating applications is a quite powerful tool. Most departments are unable to spend the time required to find diverse applicants, and students are not able to submit a large number of applications due to expense. APS is uniquely situated to collect and distribute applications to interested departments. This has proved to be immensely helpful for connecting students with departments that have the ability to support them.

Secondly, we learned that admissions data are not what they seem. Although the GRE plays a big role in admissions decisions, our research has found that it may not be actually telling admissions committees what they think it is telling them. We've also found that student perceptions of what admissions committees are looking for in applicants differ significantly from what the admissions committees actually say they are looking for.

We found that a significant barrier to graduate school for a number of bridge students has been the expense of applications.[7] Costs add up quickly when you factor in the expense of applying to each program, taking the GRE and PGRE, and sending the scores and transcripts to each school. This results in students only applying to a handful of schools, significantly reducing their chances of securing admission.

Finally, we've seen the importance of graduate and student groups in bringing students into the department culture, and in contributing to department events and decisions. Often, Physics Graduate Student Associations organize induction activities and provide peer mentoring to help give students what they need to succeed.

So where do we go from here? APS-BP plans to continue the most impactful components of the program: aggregating and distributing student applications to Bridge and Partnership sites, collecting and disseminating effective practices for retention, and advocating for admissions reform. We've also started conversations with other societies in the physical sciences, about how they might run bridge programs within their fields. Finally, we are in discussions with a number of national laboratories and industry partners about helping Bridge doctorates (the first of which we expect to be awarded in the next year) transition into their first post-graduate positions.

The APS-BP was born out of a recognized need to improve the participation of URM students in physics, as a way to diversify and strengthen the pool of domestic physicists. It has been our pleasure to have seen the impact of the program on our bridge students, and their contributions to their departments. APS-BP has enabled a number of students, who would not otherwise have had the opportunity to chase their dream of earning a doctoral degree in physics. We look forward to the important contributions these students will make to the field of physics and to the future generations of scientists they will mentor and inspire.

Erika Brown is the Program Manager for the APS Bridge Program and the APS Inclusive Graduate Education Network (IGEN) Pilot.

(Endnotes)

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3. American Physical Society. "Percentage of Bachelor's Degrees Earned by African Americans, by Major", IPEDS Completion Survey by Race and US Census Bureau. https://www.aps.org/programs/education/statistics/aamajors.cfm

4. APS Bridge Program. "Project Goals." http://www.aps-bridgeprogram.org/about/ProjectGoals.pdf

5. T. Hodapp and K. Woodle, "A bridge between undergraduate and doctoral degrees," *Phys. Today* **70**, 50 (2017).

6. T. Hodapp and E. Brown, "Making physics more inclusive", *Nature* **557** (2018).

7. G. Cochran, T. Hodapp, and E. Brown, "Identifying barriers to ethnic/racial minority student's participation in graduate physics," *2017 PERC Proceedings* [Cincinnati, OH, July 26 -27, 2017].

Physics Faculty Mindsets in Graduate Admissions

Rachel E. Scherr, Seattle Pacific University

This article is based on R. E. Scherr, M. Plisch, K. Gray, G. Potvin, and T. Hodapp, "Fixed and growth mindsets in physics graduate admissions," Phys. Rev. Phys. Educ. Res. **13** *020133 1-12 (2017).*

Much more so than experts in other disciplines, physicists agree with statements such as, "Being a top scholar of [my discipline] requires a special aptitude that just can't be taught," and "If you want to succeed in [my discipline], hard work alone just won't cut it; you need to have an innate gift or talent." Researchers interpret these findings as indicating that physics experts especially value "brilliance" – a presumed innate gift or talent that makes some people more likely to succeed than others.[1,2] These same researchers document strong correlations between this "brilliance" expectation and gender and racial/ethnic representation in various fields: The stronger the "brilliance" expectation in a discipline, the lower the proportion of PhDs awarded to women and members of certain racial and ethnic groups. The connection, according to these researchers, is that fields that especially value "brilliance" may especially discriminate against groups that are stereotyped as *not* innately gifted. The data suggest that "academics who wish to diversify their fields might want to downplay talk of innate intellectual giftedness and instead highlight the importance of sustained effort for top-level success in their field."[1]

Our research team investigated a particularly consequential occasion for "talk of innate intellectual giftedness" in physics by interviewing 18 physics graduate admissions committee chairs, asking them to describe what they look for in deciding who to admit to graduate school. The programs represented in the study were both selective (they admit less than 20% of applicants) and diversity-oriented (they prioritize diversity in their admissions practices, according to a separate study conducted by the American Physical Society).[3] Our analytical framework was informed by mindset research, in which intelligence is understood either as an inherent capacity or ability measured primarily by grades and standardized test scores (a "fixed mindset"), or in terms of acquired knowledge and effort (a "growth mindset").[4] To analyze the interviews, we deductively created a coding scheme based on the many specific findings about fixed and growth mindsets,[4] and coded the faculty interviews using this scheme.

Many of the faculty members interviewed expressed elements of a fixed mindset. The commonest code in this analysis was the code indicating statements of innate ability, suggesting that such "smart talk"[5] is common among the faculty interviewed (and/or their programs). For example, various interviewees said their aim is to "find the diamond... the obvious cream of the crop," "the top people," "the best individuals," or the "blue-chip students." Others explicitly said they were looking for "brilliance...the real stars," or "this person is a research genius." In describing their admissions practices, various faculty members made statements such as, "Most of the cases are straightforward because it all goes together...Students with high GREs are strong students all around," and "We want basically 'A' students in physics courses." This approach is likely to negatively impact the admission of women and some racial or ethnic groups, who are stereotyped as lacking high-level intellectual ability[1] and perform lower on standardized measures of achievement, including the physics GRE.[6,7,8]

Some faculty that we interviewed expressed elements of a growth mindset, describing their programs as seeking to admit students who can grow into physics excellence with support, and evaluating students partly in terms of noncognitive factors such as passion for physics, determination, perseverance, and coping with adversity. For example, some faculty members made statements such as, "If their grades show a positive trajectory, that's great... we are looking for a sense of progress," and "Success is not just good grades but also long term, will they make us proud down the road." Admissions practices in this approach included "Independence, grit, writing—qualities we want to look for in the applicant, instead of documents." One faculty member said that overall, "the purpose is to admit students who will thrive under certain very good conditions that the department is responsible for creating." This approach to admissions has improved diversity in other graduate fields.[9]

Overall, most interviews expressed elements of both mindsets. All the interviews expressed elements of a growth mindset, and almost all expressed elements of a fixed mindset. This result is evidence against the idea that the beliefs and practices associated with individuals in this study, and/or their physics programs, comprise a unitary theory of intelligence -- that individuals (or their programs) have either an entirely fixed mindset or an entirely growth mindset.

Even though nearly all interviews expressed elements of both fixed and growth mindsets, three-quarters of the interviews analyzed were associated with a preponderance of codes indicating either fixed or growth mindset. In this data set, half the faculty indicated that their program has (or they have) an overall growth mindset regarding graduate admissions, and one-fourth indicated a predominantly fixed mindset. The remaining four interviews were associated with a substantial mix of codes associated with both fixed and growth mindsets, such that a clear overall mindset was not indicated.

As stated above, programs that participated in this study were chosen because they were understood to be prioritizing diversity in their graduate admissions practices, in an environment of substantial admissions pressure. Thus, we do not expect that the results of this study are representative of graduate programs in general. Instead, the results suggest that in these selective graduate programs that are striving to prioritize diversity, about half are described by their faculty as having an overall growth mindset and one-fourth as having an overall fixed mindset.

Our results suggest that elements of both fixed and growth mindsets are common in physics graduate admissions committee members. Our analysis includes evidence that a single individual may represent a variety of convictions, corresponding to both fixed and growth mindsets. Significantly, elements of a fixed mindset persist even among those whose departments are striving to prioritize diversity in admissions. This fixed mindset manifests in both beliefs about who is likely to succeed in physics— those with innate talent—and admissions practices that emphasize undergraduate grades and physics GRE scores over other possible measures. Both these beliefs and these practices tend to exclude women and some racial or ethnic groups from the discipline.[6-8] Fortunately, our results also document a growth mindset among some graduate admissions committee members, including both growth-oriented beliefs (e.g., that students can grow into physics excellence with support) and growth-oriented practices (e.g., placing value on noncognitive factors). Programs that apply a growth mindset to their admissions processes include APS Bridge Programs associated with highly competitive physics departments, which are documented to have a high rate of student retention.[10] These programs embrace and promote cultural change, anticipating benefit to the field, while remaining committed to the academic integrity that has proven so powerful for physics in solving some of the most complex problems in the universe. As one interviewee stated: "We have to be the example of showing that nothing bad happens when you change who does the science."

Rachel E. Scherr is a senior physics education researcher at Seattle Pacific University who studies physics disciplinary culture and practices.

(Endnotes)

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2. A. Cimpian and S.-J. Leslie, "The brilliance trap," *Scientific American* **317**, 60-65 (2017).
3. G. Potvin, D. Chari, and T. Hodapp, "Investigating approaches to diversity in a national survey of physics doctoral degree programs: The graduate admissions landscape," *Phys. Rev. Phys. Educ. Res*. **13**, 020142.
4. C. S. Dweck, *Mindset: The New Psychology of Success* (Ballantine Books, New York, 2007); C. S. Dweck, *Self-Theories: Their Role in Motivation, Personality, and Development* (Taylor & Francis, London, 2000).
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10. T. Hodapp and K. Woodle, "A bridge between undergraduate and doctoral degrees," *Phys. Today* **70**, 50 (2017).

Becoming Cultural Navigators in a Graduate Physics Community

Deepa Chari and Geoff Potvin, Florida International University

Graduate school in physics can involve a host of new experiences for graduate students. These new members of the community try to make sense of a department's culture and understand the practices and members of this community. During this time, it is important that graduate students do not feel overly imposed upon by department legacies and that they successfully pass through departmental benchmarks for progress (formal and informal). Often, departments rely on faculty to support new graduate students to learn about departmental culture and expectations. Additionally, a range of programmatic structures like graduate courses, research meetings, and colloquia may be available for new students, who need to understand the meaning and importance of each.[1] In our studies, we focus on understanding the human practices that makes such programmatic structures socially meaningful in graduate enculturation.

In Community of Practice theory, practices are characterized by norms and viewpoints of the practicing members of a community.[2] Thus, practices can be studied from existing as well as comparatively new members of a community.[3] A study of graduate students' practices can also provide understanding of what kind of support faculty can offer students in the enculturation into a graduate community.

With this in mind, we interviewed 14 physics graduate students from 4 departments. All students were enrolled in the American Physical Society's Bridge Program and were in their 1st or 2nd year of graduate school at the time of the interviews. During this period, students typically complete advanced level undergraduate courses and/or graduate courses, and some start their graduate research. The interviews we conducted explored students' experiences in their initial graduate experiences. These students self-identify as coming from under-represented groups, so this study also contributes to an understanding of supporting graduate diversity.

Graduate course taking was a dominant theme in many interviews. Students described graduate course taking as an advancement of their current knowledge, and that it should be cumulative to the undergrdaute physics concepts. Some students at one department shared examples of difficulties they had initially experienced in a core graduate course. Most members of that group associated the difficulties they encountered with their undergraduate preparation in mathematics. Probing further, students added that they discussed their difficulties with their mentors and, with their support, approached the department's graduate committee with a suggestion of developing an additional mathematical methods course for them. Students commented that the department had committed to consider this and review the necessary logistics. This is a clear indication that students had not only undertaken the usual practice of graduate courses but had become active agents who were able to identify a barrier to their own success and suggest programmatic changes to lower this barrier.

Another dominant experience of students was the interaction of new (first year) students with second-year students. Second-year students engaged in critical discussions regarding graduate course selection including how many courses newcomers should take. Some of these discussions mitigated new students' worries about the extra time they invested in supplemental undergraduate course taking. Thus, the earlier cohort was taking up the mantle of more senior members of the community. In sum, graduate students themselves served as active agents in their own enculturation. As a practical concern, faculty make use of this knowledge by providing structures that create regular opportunities for interaction between cohorts and between students and the departmental committees that make programmatic and advising decisions.

Having a good GPA in graduate courses was understood to be a necessary step for continuing graduate school. In the interviews, students emphasized the importance of group work during their first-year graduate courses, some even referred to group work as the key to achieving a good GPA. Students narrated how they initiated and successfully managed working groups during course taking and to avoid isolation. Some of the strategies included moving to different offices to ensure they would be in the company of graduate students who were also taking courses, keeping office doors open to welcome each other, organizing off-campus group sessions for an extended time, strategically approaching assignments, etc. Interestingly, even after the first-term ended, most students continued to follow up on other group members' progress in other courses, their teaching, and research activities. Furthermore, they felt more connected with other group members during social events at the department. In this way, group work in the first semester courses helped to develop connectedness between students and clearly boosted the camaraderie in the graduate community.

Overall, students we interviewed had thrived in their departmental graduate communities and had navigated through and around the structures as they felt necessary in their enculturation. Departments can be proactive by considering the introduction of such student-initiated practices as standard exercise for future cohorts of graduate students.

Deepa Chari is a postdoctoral researcher associate at Florida International University. Her research interests are graduate education, enculturation studies, and students' understanding of math in physics.

Geoff Potvin is an Associate Professor in the STEM Transformation Institute and the Department of Physics at Florida International University.

(Endnotes)

1. B. E. Lovitts, *Leaving the ivory tower: The causes and consequences of departure from doctoral study*. Rowman & Little field Publications Inc, Lanham, MD (2001).
2. P. Bourdieu, *The logic of practice*. Polity Press Cambridge, United Kingdom (1990).
3. E. Wenger, *Communities of Practice: Learning, meaning and identity*. Cambridge University Press, University Printing House, Cambridge, United Kingdom (1991).

Physics Teacher Education Coalition

Section on Teacher Preparation

Teacher Preparation Section

Alma Robinson, Virginia Tech

This issue of the Teacher Preparation Section will conclude our theme of recognizing and combating the negative misperceptions of the teaching profession that many of us: students, faculty, and citizens, still hold.

Dawn Knight, the Pre-Education Advising Program Coordinator at Virginia Tech, describes the *Keep Calm & Teach On* Information Expo that she created to help future teachers celebrate teaching and learning, interact with successful teachers, and learn more about the undergraduate and graduate teaching experiences offered at Virginia Tech. The expo was geared towards helping both high school and college students who may feel uncertain or discouraged about choosing a teaching career learn more about the teaching profession.

Brigham Young University (BYU) has one of the most successful physics teacher preparation programs in the country. For many BYU students, the appeal of teaching goes far beyond tangible benefits; they teach because they hope to make a difference in the lives of young people. Duane Merrell explores a multitude of reasons his students pursue a career in physics teaching and offers us a little insight into one of his outstanding physics teachers.

Keep Calm & Teach On

Dawn Knight, Virginia Tech

Young adults who are considering teaching as a profession can sometimes get discouraged by current events and well-meaning others who may not understand or support their choice of career. At larger universities, education can be overshadowed by more 'glamorous' or novel majors. It can be especially difficult at colleges and universities where all of the teacher education happens at the graduate level. They ask, "What am I supposed to do for four years while I wait to get into a graduate program?" The *Keep Calm & Teach On Info Expo* was designed to show future education students the multiple opportunities, in and out of the classroom, that help prepare future educators while also providing some encouragement from successful professionals in the field. By making it easier to access and integrate all of the opportunities that pre-education students might encounter, we hope to develop more highly-qualified teachers who feel better connected and stay in the profession longer, lessening some of what has led to the current teacher shortage.

There is no reason for educator preparation programs to reinvent the wheel; we are not in this alone. The concept of localities "growing their own" teachers has been gaining momentum over the past several years as more and more states face increasing teacher shortages. Programs like *Educators Rising*[1] and *Teachers for Tomorrow*[2] are engaging high-school students with opportunities and experiences in the field of education, allowing them to explore interests and develop educator skills and dispositions. Coincidentally, our campus chapter of the Student Virginia Education Association (SVEA) had been looking for a way to connect with high-school students to keep them engaged and offer advice for next steps. *Keep Calm & Teach On* was born.

The idea of the information expo started out as a way to provide future students with information about what our university has to offer in terms of undergraduate and graduate opportunities for preservice teachers. During the planning, it quickly grew into more of a celebration of teaching and learning. We requested contact information from the state Department of Education and invited all Virginia high schools with teacher preparation curricula, as well as community colleges that provide teacher education coursework, to the expo. The event was also open to SVEA members across the state and current Virginia Tech Pre-Education Advising Program students. Our pilot event included almost 30 participants from Virginia Tech and two area high schools. Based on the feedback we received, we made some significant changes to the event, and our second attempt included more than 60 participants from five high schools and two community colleges, in addition to the Virginia Tech student attendees. Looking forward, we are hoping to make this an annual event that will be organized with the following lessons in mind.

Make it easy. Originally, the invitations, registration, and general information were shared in three unconnected formats. Because of security features on school email accounts, many teachers never received the first invitation. In the spring we consolidated everything a participant would need into a Google site and used Google forms, sheets, and maps for communication. We wanted the event to be free and, fortunately, we were able to partner with the School of Education and secure Student Budget Board funding on behalf of the SVEA. Because of the funding available, we were able to provide lunch, tote bags, and a bus from fleet services to move participants around our large campus. Parking is a struggle on our campus, especially during the week, so we created maps on the Google site outlining the easiest parking for individual vehicles and procedures for school buses.

Respect their time. We were mindful of the event's start and end times to accommodate those traveling from farther away. Most school systems will not pay for an overnight field trip, and we didn't want students to be on the road at 4am or getting home after 11pm, so we planned for a later start and earlier finish than other workshops. Also, for this event to be sustainable, the high school teachers needed to see it as a valuable learning opportunity. We were intentional in not making this a day-long advertisement for our program. Instead, we focused on promoting the profession and allowed interest in our program to develop organically through the event. By offering hands-on workshops for participants, we provided a hint of teacher education and a glimpse of their future classrooms. We chose to use high-impact School of Education spaces, like the Training & Technical Assistance Center (T/TAC) and the STEM Collaboratory, for our workshops and provided them lunch in one of our award-winning dining centers. There was time at the end of the event for participants to ask questions to School of Education advisors and an Undergraduate Admissions representative to ensure that everyone left with the most accurate information possible.

Maximize peer involvement. There is nothing cooler to a kid than a slightly older kid, and this event would not have been possible without our SVEA President. We involved the college students in all planning aspects because they are much more likely to know what information is most desirable and how to best engage the younger students. Our SVEA members act as ambassadors at several points throughout the school year by visiting area high schools and mentoring future education students. Through these interactions, the high school students may realize, "That could be me in a couple years!" During the Q&A session exploring different education careers and paths, we invited current students to participate as panel members, alongside program faculty, to share their experiences. Finally, we recruited Hokie Ambassadors, the student-led campus tour guides, as walkers that guided participants to and from activities. Not only did it keep our guests from getting lost, it provided an opportunity for campus trivia and more candid conversations about student life.

Build a sense of community. High levels of student engagement have been found to be associated with higher rates of student retention, success, and achievement. We wanted to let potential students know ways that they could connect with both each other and professionals in the field as undergraduates across multiple programs, so we invited relevant student organizations and community agencies to provide information about teaching-related service opportunities for college students. Since our teacher preparation program is a graduate-only program, we also wanted to share education-related courses that undergraduates can take, which helps students realize that they can be involved in teacher preparation prior to the formal educator preparation program.

Mythbusting. Giving students facts about the profession allows them to make truly informed decisions and resist some of the misinformation that is out there. Many students think that teaching is the only thing you can do with a degree in education, so we made sure to include information about other careers that are related to curriculum development, teacher development, and educational research and psychology. Another common offender is the idea that only people with no other options become teachers, implying an inherent lack of rigor. We have all heard the phrase, "Those who can do, …" There is nothing easy about becoming a teacher, whether it's the additional coursework, the testing, student teaching, or writing 50 pages of lesson plans for a 20-minute lesson. We help them see that it takes brains and determination to be a successful educator. Finally, the biggest complaint about the profession is the money, or lack thereof. While teacher salaries can be low in comparison to many other professions, pay scales are related to the degree earned, years worked, school system, and include benefits that are not a part of salaries from all careers.

Calling all superheroes! Teaching has an image problem, and if we are going to retain the best and the brightest, we need to counter the bad press. The media is full of examples of the negative aspects of teaching; from criminal teacher behaviors to failing public policies and unimaginable teaching conditions. While there is plenty of room for improvement, there are teachers out there who are having an impact. We knew we needed a speaker who could empower future educators to defend their career choices. We looked for someone to inspire students to not walk away, but to march forward and make a difference through teaching. In my role as an academic advisor, I hear so many students say they have always thought about teaching, but for whatever reason, thought they should do something else. I was that student once. I resisted teaching for years until I read Taylor Mali's poem, "What Teachers Make." I was empowered; teaching mattered. I was good at it, it was important, and it didn't matter what anyone else thought. There are teachers out there making a difference and education hopefuls need to hear their stories. Successful educators can share struggles as well as successes and provide first-hand accounts of what the profession is really like. We were fortunate to have the 2018 Virginia Region 6 Teacher of the Year and the 2017 Level Up Village's U.S. Teacher of the Year (STEM) as our keynote speakers. A simple Google search will turn up educators in your area that have been honored for their contributions and are eager to reach out to the next generation.

Students who are exploring the teaching profession need factual information and hands-on experiences so that they can make career decisions for themselves. They need to know that they are not alone. They need assurances that they are doing the right thing and have the flexibility to change their plans. As a pre-education advisor I support students who want to be teachers, and those just considering their options. At the same time, I share the realities about the field and guide students toward other paths if the classroom is not right for them. I also believe it is important to let others know that teaching is a legitimate career with pros and cons just like any other. *Keep Calm & Teach On* was a wonderful opportunity to spread a positive message for teachers and I look forward to finding more ways to reach out to future educators.

Dawn Knight is the Pre-Education Advising Program Coordinator and an instructor in the School of Education at Virginia Tech. She is also a doctoral candidate in Curriculum and Instruction specializing in Curriculum Development and Teacher Education. She serves as the faculty advisor for the Student Virginia Education Association at Virginia Tech and is the National Academic Advising Association (NACADA) Education Majors Advising Community Chair.

(Endnotes)

1. Educators Rising is national program that cultivates highly skilled educators by guiding young people on a path to becoming accomplished teachers, beginning in high school and extending through college and into the profession. https://www.educatorsrising.org/
2. The Virginia Teachers for Tomorrow Curriculum is part of a is a long-term recruitment strategy to increase the pool of candidates who will be able to fill critical shortage vacancies, increase the diversity of teacher applicants, and promote the hiring of local candidates who are more likely to remain within their school divisions. http://www.doe.virginia.gov/teaching/educator_preparation/teachers_for_tomorrow/

So, Why Do You Want to Be a Teacher? Maybe the Negatives Are Actually Positives

Duane Merrell, Brigham Young University

It might seem impossible to convince students to become physics teachers. Why would they want to enter a profession with so many challenges? To join a profession that gives ever growing class sizes of middle and high school students, funding shortages, and little time for preparation? Further, a teacher's duties don't end in the classroom. A teacher is a counselor, hall monitor, track coach, lunch duty monitor, STEM club advisor, detention monitor, honors advisor, dance chaperone, ticket taker at school events, engineering club mentor, Saturday School teacher, senior class advisor, accreditation team member, district science supervisor, science department head, and the list goes on and on.

Why would anyone go into teaching? In the Physics Teaching Program at Brigham Young University (BYU), we find that some of the reasons our students choose to teach are often the same as the reasons that keep others from the profession. Students choose physics teaching for the chance to help, mentor, direct, and empower students in the same way that a teacher helped, directed, and empowered them.

BYU physics teaching majors are drawn to the profession so they can teach of course, but also so that they can participate in the growth of students in ways that extend beyond the classroom. These students were influenced in the band room, on the soccer field, with the Science Olympiad team, in the choir, on the football field, in the math club, in peer helper groups, in the tutorial labs, and these, as well as many other influences, draw them toward teaching. These young teachers don't view it as a hardship to teach but rather as a way to give back to the system that shaped them into the teacher they want to be.

Students teach because they *want* to be the engineering club advisor or the science Olympiad coach. Some *want* to help with the school play, or even be a class advisor. Why a teacher would want to be a student council advisor, I do not know, but I do know that these young teachers sometimes thrive with all the little extra duties that many would think might deter students from choosing teaching as a career.

Most of the students in BYU's physics teaching program have already worked directly with others through two years of service. About 75% of all BYU students have lived and taught in locations with different cultures than their own and have even developed language skills to connect with others. These personal interactions of being able to witness the change that education can bring in an individual person's life seem to resonate with the teaching students, and it creates a desire to continue to make a difference in other people's lives. Teaching, and the satisfaction of teaching and empowering people to grow and succeed through education, is a driving factor in BYU students deciding to become physics teachers.

Daniel Lynn

Daniel Lynn, a physics teaching major who just completed his first year as a physics teacher, perfectly demonstrates these traits. Instead of student teaching with a mentor teacher present at all times, Daniel was a teaching intern. This means that Daniel was *the* teacher in the classroom for the full year. While he collaborated with the physics teachers at the school and received support from BYU's mentors and supervisor, it was really just him, the lessons he developed, and the students. Despite these challenges, as well as the financial challenges of paying for tuition while only being paid a half salary for this internship, Daniel thrived. What made Daniel do this? Why would someone with no experience walk into a teaching job for half of the salary that a teacher next to him earns in order to finish his physics teaching degree? I think it's Daniel's desire to make a difference through teaching physics. I visited Daniel's classroom often over the past nine months and these visits helped me feel good about the job I am trying to accomplish – to mentor and develop new physics teachers. What other job brings a new task, maybe a refreshing problem, and possibly even a new challenge each day?

With only a tennis ball, Daniel can engage his students in trying to understand the vertical and horizontal components that describe the motion of a projectile. As Daniel and his students toss the ball back and forth, they don't even notice that they are learning – that each toss conveys an idea that they will be discussing that day. Watching these interactions helps me appreciate the talent of these young teachers.

Daniel's motivation to teach is something that I am not sure I can even describe, but there is a real piece of him that resonates when he works with students. It's a grand adventure that goes beyond physics; it is both the connection they build as something is learned and the deep rewards that come from understanding each other.

Although Daniel could find a comfortable, well-paying teaching job next year, he is taking his skills overseas to further his big adventure teaching students physics.

The reasons someone may choose not to teach are many times the same reasons others choose to.

Duane Merrell is a faculty member in the Department of Physics at Brigham Young University (BYU) responsible for physical science teaching students at BYU who are earning Earth Space Science, Chemistry, Physics, and Physical Science degrees. BYU moved the preparation of these secondary education physical science teachers from the College of Education to the College of Math and Physical Science in 2004, and has graduated more than 175 students in the past 12 years, with 139 as certified physics teachers.

Browsing the Journals

Carl Mungan, United States Naval Academy, mungan@usna.edu

- Cameron Reed estimates the yield of a fission bomb on page 105 of the February 2018 issue of the *American Journal of Physics* (http://aapt.scitation.org/journal/ajp). An article on page 119 of the same issue compares theory and experiment for fluid sloshing inside a partly filled bottle rolling down a slope, or along the floor and bouncing off a wall. The March 2018 issue has an article on page 169 that explains why a line of color (green if held horizontally) appears diametrically across a CD exposed to white light from the side. Another article on page 206 investigates in detail how a pot-in-pot cooler works. Finally, Dean Pesnell on page 338 of the May 2018 issue considers what the trajectory of a cannonball launched horizontally off a tall mountain would be if the the ball could freely pass through the earth treated as a sphere of uniform mass density.

- An article on page 149 of the March 2018 issue of *The Physics Teacher* (http://aapt.scitation.org/journal/pte) presents data showing that there is a correlation between hours of sleep the night before a final exam and score on that exam. Joe Amato explains how the range of an ICBM can be estimated from its observed maximum altitude on page 210 of the April 2018 issue. The same issue on page 222 discusses a video of the motion of a two-ball Newton's cradle where the mass ratio of the two balls is 3:1 which can be watched at https://aapt.scitation.org/doi/suppl/10.1119/1.5028235/suppl_file/222_1-mova.mov. Also see if you can deduce the simple rule for the dice game "Petals Around a Rose" discussed on page 262; test your prediction at http://www.borrett.id.au/computing/petals-j.htm. An article on page 317 of the May 2018 issue puts a drone quadcopter in vacuum to determine whether the change in pointing direction is due to conservation of angular momentum or atmospheric drag when the speed of the blades is changed. The iPhysicsLabs column on page 324 of the same issue measures the drag coefficient of a car, bus, fire engine, and cyclist.

- Article 024003 in the March 2018 issue of *Physics Education* rebuts many of the common concerns about nuclear energy. Discussion of cameras and example ideas of slow-time-lapse recordings (over a period of hours or days) for physics analysis is found in articles 035019 and 035030 of the May 2018 issue. A Lagrangian-based model of the pressure and density in a sonoluminescent bubble is presented in article 025807 of the March 2018 issue of the *European Journal of Physics*. Both journals can be found online starting at http://iopscience.iop.org/journalList.

- Deepak Dhar on page 183 of the February 2018 issue of *Resonance* proposes that mathematics is invented not discovered, and hence a number such as π did not exist thousands of years ago. Also an article on the Maragoni effect in fluid mechanics on page 225 of the same issue has links to wonderful videos of effects driven by surface tension gradients. Another article on fluids with links to lovely videos is on page 491 of the April 2018 issue presenting the behavior of air bubbles in liquids. These articles can be freely accessed at http://www.ias.ac.in/listing/issues/reso.

- Cyclic voltammetry is reviewed for beginners on page 197 of the February 2018 issue of the *Journal of Chemical Education*. An interesting study on page 347 of the March 2018 issue investigates what kinds of textbook illustrations best promote student learning. The journal archives are at http://pubs.acs.org/loi/jceda8.

Web Watch

Carl Mungan, United States Naval Academy, <mungan@usna.edu>

- The SciCafe channel on YouTube at https://www.youtube.com/playlist?list=PLrfcruGtplwG0Dj6cSfmH7RVnIP7CDirG has videos on science talks for the public that are typically 20 to 30 minutes in length.

- Another YouTube channel worth browsing is Spangler Science at https://www.youtube.com/user/SpanglerScienceTV. Also see Iron Science Teacher at https://www.exploratorium.edu/video/collections/iron-science-teacher.

- GitHub has an excellent student guide to MATLAB (written by textbook authors Nelson and Dodson) available at https://github.com/NelsonUpenn/PMLS-MATLAB-Guide.

- Explore activities for teaching optics to children at https://www.optics4kids.org/. More broadly for a similar age group, browse Engineering Everywhere at https://www.eie.org/engineering-everywhere or JPL's Engineering in the Classroom site at https://www.jpl.nasa.gov/edu/teach/resources/engineering-in-the-classroom.php.

- Striking high-resolution microscopic photographs of insects can be viewed at http://microsculpture.net/microsculpture.html.

- A technique to map 2D thermal properties of a surface with nanometer resolution is discussed at https://physics.aps.org/articles/v11/12.

- A novel method of explaining the Fourier transform visually is presented at https://youtu.be/spUNpyF58BY. Also see the visual introduction to probability and statistics at https://students.brown.edu/seeing-theory/?vt=4.

- A variety of educational resources related to seismology are available starting from https://www.iris.edu.

- If, like me, you had a chemistry set as a child, you may enjoy browsing http://chemistryset.sciencehistory.org.

- A detailed website about the last Apollo mission to the Moon is at http://apollo17.org/.

- Academic genealogies (i.e., who was whom's Ph.D. advisor) can be created and browsed at https://academictree.org/physics/.

- National Geographic has richly illustrated maps of bird migrations at https://www.nationalgeographic.com/magazine/2018/03/bird-migration-interactive-maps/.

- View a home movie filmed at the 1927 Solvay Physics Conference at https://youtu.be/8GZdZUouzBY.

- Delft University of Technology has started an online journal called "Superhero Science and Technology" at https://journals.library.tudelft.nl/index.php/superhero/index.

- A website devoted to Isaac Newton's involvement in alchemy is at http://webapp1.dlib.indiana.edu/newton/.

- A real-time 3D map of stuff orbiting the Earth can be viewed at http://stuffin.space/.

- NIST has a webpage devoted to the history and future of quantum information at https://www.nist.gov/history-and-future-quantum-information.

- NASA has a website devoted to astrobiology at https://astrobiology.nasa.gov/.

- Finally, an interactive map of live radio streams around the world is online at http://radio.garden/live/.

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