APS physics™

FORUM ON EDUCATION

American Physical Society

Fall 2021 Newsletter

Jennifer Docktor, Editor

From the Chair

***Catherine Crouch**, Swarthmore College*

I am excited to announce the education-related awards presented by the American Physical Society honoring outstanding contributions to education. The first is the *Excellence in Physics Education Award*. The awardee for 2022 is the **TEAM-UP Task Force,** "For groundbreaking analysis revealing sources of persistent underrepresentation of African-Americans in physics and astronomy; recommendation of data-driven, systemic strategies to increase the number of African-American physics bachelor's degree recipients; and ways to catalyze cultural change." This 12-member group produced the TEAM-UP report, the findings of which have informed departments and institutions large and small how to promote greater access and equity.

This award is unusual for APS because it invites the nomination of either teams or individuals who have demonstrated a "sustained commitment to excellence in physics education." If you have ideas for deserving recipients, please nominate them for the 2023 award! The deadline is June 2022; nomination information can be found on the award web page.

The second award the FEd is responsible for is the Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction. The 2022 winner is Sean Robinson from MIT, "For leading and helping to develop Junior Lab, MIT's advanced physics laboratory, and for pedagogical excellence that extends to the broader advanced physics laboratory community." The award honors individuals for outstanding achievement in teaching, sustaining, and enhancing an advanced undergraduate physics laboratory course. This important work often goes unrecognized (especially beyond the walls of a physics department), so please think about worthy physicists you may know and consider nominating them. Nomination information can be found on the award web page; nominations are due in June.

A third award for education is administered by the APS Committee on Education. This is the Award for Improving Undergraduate Physics Education, which recognizes excellence and best practices in undergraduate physics education. If you are a member of a physics department or program that you think exhibits these qualities, please consider submitting an application for this award. The 2022 awardees will be announced soon, and the deadline for applications for next year's awards is June 2022.

APS has announced the newly-elected APS Fellows. This year we have three Fellows nominated by the FEd Fellowship Committee (led by Past Chair Jerry Feldman) for their significant contributions to physics education. They are:

Beth A. Cunningham (American Association of Physics Teachers): "For efforts supporting teachers and educators in physics at all levels on a global level, and for significant contributions to the physics community in identifying areas of focus in physics education and for promoting equity, diversity and inclusion in physics learning."

Valerie K. Otero (University of Colorado, Boulder): "For the creation and broad dissemination of innovative physics curricular materials, pioneering contributions to physics teacher education and professional development, and for the development, implementation, and wide dissemination of the Learning Assistant Model across diverse institutions."

Katherine K. Perkins (University of Colorado, Boulder): "For profound contributions to physics education through the vision and leadership of the PhET project, resulting in the creation of many high-quality interactive simulations for teaching physics to hundreds of millions of students and teachers globally."

Please join me in congratulating all of these outstanding colleagues for their contributions to our shared educational enterprise.

November is election month for the FEd Executive Committee as well as the US government. By now, FEd members should have received an e-mail ballot message. Balloting will close on 19 November, and the new Vice-Chair and Members-at-Large will begin their terms on 1 January 2022. The Secretary-Treasurer and the Members-at-Large serve for three years, while the Vice-Chair moves up the line to Chair-Elect, Chair, and Past Chair in subsequent years. I am very grateful for the excellent work of the Nominating Committee (led by FEd Vice-Chair Susan Blessing) in an unusually demanding year, developing an outstanding slate of candidates, and I look forward to working with the new executive committee members.

One of the most prominent activities of the Forum is to organize invited sessions on education topics to be presented at the APS March and April meetings. Program Chair (and Chair-Elect) Eric Brewe and his committee have been hard at work all summer putting together outstanding sessions for hybrid March and April APS meetings.

Finally, I want to ask you to invite any colleagues you have who care about education to join the FEd. It's free! APS members can join as many Forums as they like without paying additional dues. The size of our membership signals to APS how important education is to members of the Society, and the allocation of meeting sessions and Fellowship slots is tied to membership. So, please help us connect with all APS members who care about education, whatever role they have and however education is or is not part of their professional work. All physicists are affected by the outcomes of physics education, so let's demonstrate our support for the commitment of APS to promote effective physics education for all.

Returning to In-Person Meetings: FEd Sessions at the March and April Meetings

Eric Brewe, *Drexel University*

As we plan for a return to in-person conferences, The Forum on Education is sponsoring a number of exciting invited sessions at the 2022 March and April meetings.

At the March meeting, FEd is sponsoring or co-sponsoring four sessions. The first session is an invited/contributed session for the Reichert Excellence in Advanced Laboratory Instruction Award session, where Sean P. Robinson of MIT will be honored for "*... leading and helping to develop Junior Lab, MIT's advanced physics laboratory, and for pedagogical excellence that extends to the broader advanced physics laboratory community."* FEd members who are working in the area of advanced labs are encouraged to submit contributed abstracts for consideration in this session.

The second invited session at the March meeting will address Science Communication, which will feature speakers with a wide ranging set of science communication experiences. The final invited session will be Professional Society Efforts in Education, featuring speakers from EP3, the IDEA Network, STEP-UP, and IGEN. In partnership with the Division of Quantum Information we will have an invited/contributed session.

At the April meeting, FEd is sponsoring or co-sponsoring six sessions. The first, session recognizes the TEAM-UP project with the Excellence in Physics Education Award session.

In addition, sessions for the April meeting sessions will include two sessions co-organized with GPER: Active Learning in Upper Division Physics and Improving Student Reasoning in Physics: What the research says. In collaboration with the Forum on Outreach and Engaging the Public (FOEP) we will have a session on Outreach in Formal Settings. In collaboration with the Division on Computation (DCOMP) we will have a session on Integrating computation into the physics curriculum. The last two invited sessions will be on Teaching to Build Physics Identity and Programmatic Efforts Changing Physics Education (Organized by AAPT).

It promises to be an engaging set of meetings thanks to the work of the FEd Program Committee: Idaykis Rodriguez, Charles Ramey, Brad Conrad, Steven Goldfarb (FOEP Member), Brian Beckford (at large member). As well, Alexis Knaub and Toni Sauncy of AAPT were invaluable. See you in Chicago or New York!

What we can do about the severe teacher shortage

David May, *Project Manager and Research Manager, Get the Facts Out*

Teaching is a wonderful career for many people, but there is a shortage of grade 7-12 STEM teachers. Our colleges and universities aren't preparing enough of them, even though about half of undergraduate science and math majors say they have some interest in teaching.

A big part of the problem is that many students don't have an accurate understanding of what the teaching profession is like, and many faculty don't know how to inform them. That's where Get the Facts Out comes in.

What is GFO?

GFO is a unique project that is designed to reach STEM majors in a large fraction of all U.S. mathematics, chemistry, and physics departments and has the potential to significantly address teacher shortages in these high-need STEM disciplines. Many members of the APS Forum on Education are actively involved in the project, using research-based messaging and tools to change perceptions of the teaching profession and recruit more students to their science- and math-teacher education programs.

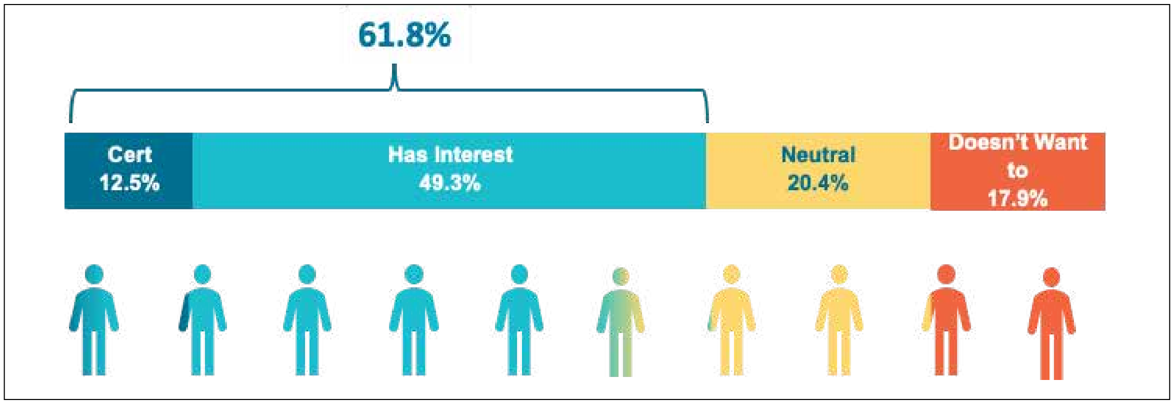
Here are some tidbits of those messages and tools, including some new ones for those of you who are already familiar with GFO.

The messages

After a lot of research and trial and error, GFO has identified some of the most important facts to share with different audiences, and effective ways to share them so that they'll have accurate perceptions of STEM teaching. Most of these are in the form of "Did You Know…?" questions, such as:
Did you know that teachers in the U.S. rate their lives better than all other occupation groups, trailing only physicians?

As it turns out, language with more negative connotations (like "misperceptions" or "myths") is not as effective.

Another very important message (did you know?) is that about half of all science and math majors report an interest in becoming a teacher. This surprises many people, but GFO's own research has confirmed this finding in many institutions around the country. Below is a pictogram display-



Responses from a series of nine statements that directly address a student's interest in becoming a grade 7-12 math or science teacher. Planning to Pursue Certification includes those who agreed to either "I plan to pursue certification at my institution" or "I plan to pursue certification through another route". Has Interest includes those who agree with any of the four I would if (IWIf) statements and/or those who agreed to "I want to become a grade 7-12 teacher" (WTT) but did not agree with either certification statement. Neutral includes those remaining who neither agreed nor disagreed on any one of WTT, either certification statement, or IWif statement. Doesn't Want to Teach includes those who disagreed with all seven statements – WTT, certification, and IWif statements.

ing data from the Perceptions of Teaching as a Profession survey (N=2,358 STEM majors).

You can read about more "Did You Knows?" and the research behind them on GFO's Facts & Data page.

The resources

There are the messages, and then there are ways to get them out there to students and those who talk with them about career options. GFO has created a number of free resources and strategies for faculty to use, each taking anywhere from 1-2 minutes to 90 minutes to implement. *Resources* include posters, data handouts, presentations (for faculty as well as for students), a regular blog, and even several recorded videos. All of them include research-based messages and can be customized to include information about your own program(s).

The presentations designed for students and for faculty are especially effective at changing perceptions. The average normalized gain on a pre/post survey (embedded in the presentations) is typically 55-60% with a typical effect size of 2.0, which is very large for an educational study. These strong results hold for a variety of presenters (i.e., not just for project staff), so long as they present with the best practices GFO has been studying for many years.

The *strategies* are designed to help you reach your students effectively, test your own knowledge, and take the next steps to improve recruitment of STEM teachers.

What's new?

A Teacher's Life, By the Numbers

Ever wondered what teachers make in your neck of the woods? And what is the cost of living in the same region? These easy-to-understand infographics, based on in-depth research for several regions of the country, are a great way to show students (and faculty) some solid numbers about what a teacher can expect to make, spend, etc.

Taking the Next Step

So you've found a student or three who have expressed an interest in a teaching career. That's great! The next step for you is to talk to them about *their* next steps. This handy guide will help you figure out what to say, how to say it, and what not to leave out.

Who knew retirement would be so popular?

Did you know? Most teaching jobs have better retirement benefits than other jobs you can get with the same degree. And it turns out, a lot of students we surveyed really care about that (and many other students, too, according to this study). What's more, GFO's very informative blog post about how teacher retirement plans work has received thousands of hits since it was published just a year ago, and accounts for the *majority* of GFO's website traffic.

More about GFO

Get the Facts Out is an NSF-funded partnership between the Colorado School of Mines and four national societies: American Physical Society, American Chemical Society, American Association of Physics Teachers, and the Association of Mathematics Teacher Educators. The project is supported by NSF DUE-1821710 & 1821462.

David May is the Project Manager and Research Manager for the Get the Facts Out project, based at the Colorado School of Mines. Trained in physics education research, he has managed or evaluated STEM education programs for the past 20 years, most recently the Physics Teacher Education Coalition.

APS Education News

Michael Wittmann, *APS Head of Education*

Hello, from the new Head of Education at the American Physical Society. Since June 1, I've been learning about the many rich programs that serve our society members, and starting to lead some of them alongside the many of you that play a role in guiding the APS in its work. By way of introduction, I want to focus on three major projects and tell you a little about some work being done to strengthen education efforts at APS.

Effective Practices for Physics Programs Guide

College and university teaching and learning cannot be successful without a strong physics department. The Effective Practices for Physics Programs Guide (EP3 Guide) is designed to strengthen departments in a multitude of ways. At the moment, it's still being built, but already it's playing a role in helping departments. Perhaps you are a department under threat in some fashion - we have materials for you to improve your situation. Perhaps you are seeking to increase your enrollment through either recruitment or retention efforts (or both!) - we have suggestions built on expert input to help you. Perhaps you need to carry out a program review in the near future - we have sections that can guide you through the process. The EP3 Guide is a fabulous achievement, though it is not yet complete. Eventually, it will be a tool to be used by all educators and all departments to improve the framework of their work in teaching and learning.

Get the Facts Out project

Of course, we won't have departments if we don't have students to teach. Without the effective teachers of tomorrow, we won't have the scientists to do the physics that will be done in the future. Teachers raise aspirations, guide careers, and build relationships that foster learning, growth, and understanding. APS is involved in two projects in this area. In the Get the Facts Out project (GFO), being done in collaboration with the American Association of Physics Teachers (AAPT), American Chemical Society (ACS), and the Association of Mathematics Teacher Educators (AMTE), we are looking to change perceptions about teaching and teacher recruitment. There are myths about teaching involving pay, job retention, and job satisfaction. By addressing these myths, as well as focusing on things like professional freedom, retirement benefits, and other aspects of teaching, we are able to change students' (and faculty!) perceptions about teaching. To learn more, check out the article on GFO, "What we can do about the severe teacher shortage," by David May in this issue of the newsletter.

Physics Teacher Education Coalition

Once students are considering a career in teaching, what then? The Physics Teacher Education Coalition (PhysTEC) has been in existence for 20+ years, helping institutions graduate qualified physics teachers from nearly 60 institutions over that time. Expanding our reach is important, with the idea that many schools making small changes (just one teacher graduate more per year!) add up to large changes in the world of teacher education. We estimate that over 550,000 students have been taught by PhysTEC graduates, with 60,000 taught last year alone. We have a long way to go, but are learning more every year about what makes a successful physics teacher education (PTE) program. We're also learning that departments with successful PTE programs typically have growing physics programs, overall.

These are exciting times for Education at APS. Stay tuned for more updates in the coming months!

PhysTEC Section on Teacher Preparation

Alma Robinson, *Virginia Tech*

In the first article for this issue of the Teacher Preparation Section, Jon Anderson, the Teacher in Residence (TIR) coordinator for the APS/AAPT PhysTEC project, chronicles how the TIR position has evolved over the past twenty years. He describes the various roles that TIRs perform at their institutions, including serving as recruiter, advisor, and mentor for future teachers; teaching and developing content and pedagogy courses; and being an ambassador to schools of education, local school districts, and local teacher communities. Anderson also explains how several TIR models have been successful, from a single TIR holding a full time position to multiple, part time TIRs working together to share responsibilities.

Many high school physics teachers would like to deepen their understanding of physics. Some may have majored in a different discipline and only took a few physics courses in their undergraduate study, while others need graduate-level physics coursework to be qualified to teach dual-enrollment classes, courses where high school students earn both high school and college credit. In the second article, Robynne Lock and William Newton of Texas A&M University-Commerce discuss their fully online M.S. in Physics with Teaching Emphasis (MPTE) program to meet these various needs. The program integrates physics education research throughout the core curriculum to improve teachers' pedagogical content knowledge (PCK) and their metacognition, skills which will help them effectively bring their knowledge to the classroom.

The Teacher in Residence Position-Twenty Years in the Making

Jon Anderson, *University of Minnesota*

Introduction

For 20 years, the Physics Teacher Education Coalition (PhysTEC) project has been working to solve the nation's shortage of well-trained and highly qualified high school physics teachers. Nationwide, enrollment in physics classes has been growing rapidly. In fact, in the first 18 years (2001 – 2019) of the PhysTEC project, the number of students completing a high school physics class increased by over 65% (from 931,000 to 1,543,000) [1]. However, fewer than half (40.8%) of all high school physics classes are taught by someone with a degree in physics or physics education[2].

PhysTEC was started in 2001. It is led by the American Physical Society (APS) and the American Association of Physics Teachers (AAPT), with support from the American Institute of Physics (AIP). The mission of PhysTEC is to improve and promote the education of future physics teachers. In this time, it has supported innovative teacher education programs at more than 50 different institutions across the country. The institutions, which are a mix of private, public, and minority-serving institutions, applied for and were selected to receive PhysTEC funding to support their efforts to prepare more highly qualified high school physics teachers. A Teacher-in-Residence (TIR) has been a consistently utilized and critical component of these physics teacher education efforts.

Teacher-in-Residence Description

The original concept for the TIR was that the institution would hire a locally based, experienced, high school physics teacher for a one-year, full-time appointment in the physics department. This person would work closely with the site leader on all aspects of the teacher preparation program. Furthermore, it was thought that after one year, the TIR would return to their high school classroom. Although the original concept has been successfully implemented by many institutions, the TIR position has evolved considerably over the lifetime of the PhysTEC project. As a result, there are many successful approaches that have emerged and enhanced the original concept. These approaches will be discussed in a later section of this paper.

TIR Roles

TIRs serve in many different roles in teacher preparation programs at PhysTEC supported sites. Listed below are the typical roles in which TIRs often serve and a short description of each role. It should be noted that the time that the TIR spends in each of these roles varies considerably depending upon the institution, the time in the semester, (beginning, middle, or end), and how well the site's physics teacher preparation program is established, to name a few.

Recruiter: Discuss the nature of the teaching profession with students and faculty, including its rewards and challenges, and promote it as a viable career option.

Advisor: Engage future teachers in one-on-one interactions and track the progress of students over time, providing individualized attention and support.

Instructor: Teach or co-teach methods and/or content courses, bringing practical insights from the classroom and providing a stronger physics emphasis to general science methods classes.

Course and curriculum developer: Improve laboratory, content, and methods courses with insights from the classroom.

LA/TA leader: Develop the teaching skills of Learning Assistants (LAs) and Teaching Assistants (TAs), by individual interactions or by teaching a pedagogy course; take on administrative tasks in organizing LA or TA training programs.

Mentor: Provide critical mentoring support for future and new teachers; serve as a university supervisor for student teachers.

Professional Community Leader: Bring together prospective and practicing teachers to meet and communicate on a regular basis.

Program Coordinator or Team Member: Take on responsibilities for the teacher education program that faculty cannot, due to lack of time or experience; improve a program by identifying elements that are missing and then developing strategic solutions.

Professional Development Provider: Design and deliver workshops to support local teachers, and develop demonstration shows to excite and teach school children about physics.

Ambassador to School of Education: Build stronger ties between physics departments and schools of education, for example, through discussions or joint meetings.

Ambassador to School Districts: Build relationships with local teachers and districts, for example, through placements or exchanges of teaching ideas.

As was noted previously, the time commitments to each of these roles varies considerably. However, A detailed accounting of the time commitments from previous TIRs (both full-time and part-time) has shown that TIRs spend:

- Approximately 50% of their time engaging in instruction and instruction-related activities. This includes tutoring, working with LAs, and course revision.
- 15 – 20% of their time engaging in mentoring and induction related activities.
- 5 – 8% of their time directly involved in recruiting and outreach activities.
- The remainder of the time was distributed throughout the other activities that are listed as well as some that are not.

It is worth mentioning here that the time spent in the "recruiting" category is difficult to quantify. Although there may be specific, defined, formal recruiting events and activities scheduled at an institution, the TIR is often engaged in informal recruiting activities as well. This happens in conversations with LA's, with undergraduate physics students, and simply by being the "face of high school physics teaching" at their institution. Many informal conversations with students often turn to discussions of teaching physics, and thus an informal recruiting opportunity.

Types of TIR Models

PhysTEC supported institutions have utilized a variety of TIR models throughout the history of the project. There have been 85 different TIRs, and the models that are described below have evolved to best suit the needs of the site, the strengths of the TIR, and the TIR's availability to commit to the position. Factors such as local demographics, geographic location of the site, enrollment, and the numbers of local teachers to work as TIRs are all factors in determining the best type of TIR model for the institution.

Full-time TIR: This is the most common model. This is typically a local teacher that is willing and able to leave their school for one or two years to serve in this role.

Part-time TIR: Several sites have hired TIRs on a part-time basis. The time commitments of these TIRs have ranged from a few (~5) hours per week to 20+ hours per week. These have generally been local teachers who continue to teach part-time in their school as well as work in the TIR position.

Multiple TIRs: Some sites have hired from 2 – 4 TIRs to share the duties of the position. These have generally been local teachers who continue to teach full or part-time in their school as well as work part-time in the TIR position. Each TIR has specific duties and they meet on a regular basis with each other and a site leader.

Retired Teacher TIR: Retired physics teachers have worked as TIRs in time commitments ranging from very part-time to full-time plus.

Conclusion

Experienced high school physics teachers have the background and ability to fill many key roles in an institution's physics teacher preparation program. PhysTEC has long considered a TIR to be an integral part of the teacher preparation program. As the project continues to grow and build on its successful history of addressing our nation's critical need for highly qualified physics teachers, the TIR will continue to have an impact.

See the TIR page [3] on the PhysTEC website for more information about the position. Additionally, a more thorough description of the position can be found in the Teacher in Residence chapter of the book Recruiting and Educating Future Physics Teachers [4].

Jon Anderson works as a consultant for AAPT as the PhysTEC TIR Coordinator and as the PhysicsBowl Academic Coordinator. Additionally, he is a Physics Instructor at the University of Minnesota and a Clinical Supervisor of science student teachers.

References

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In-service physics teacher education through an online Master of Physics Degree

Robynne Lock and William Newton, *Texas A&M University-Commerce*

Many high school physics teachers are interested in deepening their knowledge of physics; only about a third hold a physics degree [1], and those who received their training outside of physics require substantial support [2]. One way to provide this support is by earning a master's degree in the field. However, there are few master's programs that target physics for high school teachers specifically, and those that do tend to be in-person and require teachers to travel to campus at times that may be incompatible with their other commitments.

At Texas A&M University-Commerce, a regional university of the A&M system located in rural, northeast Texas, we have developed a fully online M.S. in Physics with Teaching Emphasis (MPTE) program to meet the needs of these teachers. We have aimed to: create a physics master's program accessible to high school teachers without a physics bachelor's degree; to prepare teachers to instruct physics up to and including community college level better than a traditional master's in physics; and to create a community of practice of teachers with a wide range of experience and background. Our program is the only one of its type that is offered fully online, and almost half of our students are from outside the state of Texas. Since its beginning in 2014, the MPTE program has grown to an enrollment of over 50 teachers. We typically graduate about 15 teachers per year.

Over half of the teachers that enroll do not have a physics bachelor's degree. However, our program builds on the content knowledge teachers have built through their practice, their advanced learning skills, and their motivation to allow them to succeed in earning a master's degree in physics. This then opens the door for them to be able to teach dual credit and community college physics classes.

The classes for this course-based master's program are offered asynchronously so that teachers may complete their coursework at times that work with their busy schedules. Regular live office hours offset the lack of synchronous instruction. To optimize this degree for teachers, we did more than move the traditional physics courses online. We developed new versions of the core graduate courses: Math Methods, Classical Mechanics, Electricity & Magnetism, Quantum, Thermodynamics, and Astronomy and Astrophysics, as well as a research literature class and a new physics elective. The remaining credit hours come from any other master's level STEM or education class.

Each core course presents the advanced physics content through the lens of physics education research (PER) and expands on the traditional content. PER is a rapidly growing field of physics that is often not touched upon in core physics graduate coursework. We integrate PER throughout. For example, in Math Methods, the students read six journal articles on the topic of how students use math in physics. This serves to reinforce teachers' pedagogical content knowledge (PCK) and improves their metacognitive skills making them better able to make use of mathematical representations in physics. PER journal articles selected from each content area are included in each of the core courses. We approach topics in ways that will help teachers to bring their knowledge into the classroom. Conceptually difficult concepts are explored thoroughly: for example, we discuss the imperfection of the disorder analogy for entropy and better ways to conceptualize it.

Typical graduate textbooks follow a set curriculum, but physics has continued to evolve since they were written. It is important that teachers are sufficiently informed in recent advances so they can convey to students the scope of physics research, so we spend time discussing modern research. In Electricity and Magnetism while studying magnetostatics, teachers read about the 2014 experiment in which a Dirac monopole was created. In Classical Mechanics, students read about modern experiments examining the nature of friction. In Astronomy and Astrophysics, students participate in citizen science projects using publicly available data.

We also recognize that teachers need to understand the scientific process and the historical context of physics. Textbooks often repeat what previous textbooks included, and this can lead to distortion of the facts and an inaccurate impression of how physics actually advances. The teachers read foundational papers such as Benjamin Franklin's letter describing the well-known kite experiment and excerpts from Maxwell's "On Faraday's Lines of Force" when they take Electricity and Magnetism. These readings are then used as jumping off points to discuss how the portrayal of the history of physics affects the teaching of physics. In Quantum Mechanics, the original Blackbody papers of Planck are contrasted with the common impression that Planck was motivated by the ultraviolet catastrophe. They get to discover themselves that it was actually small experimental discrepancies in the infrared that kick-started the quantum revolution. This contains a good lesson for students that would otherwise be missed – that paying attention to the small details is what often leads to the biggest advances. In addition, the whitewashing of physics history is addressed throughout. In the Astronomy and Astrophysics class, for example, teachers analyze the orbital mechanics papers Katherine Johnson wrote at NASA.

One of our program's biggest strengths is the resulting community of teachers. At the heart of each of our courses are discussion boards. Discussion prompts are based on reading assignments, lecture videos, or problem sets. Teachers share their ideas, experiences, and teaching resources. This provides a much needed resource for those that are the only physics teacher, or possibly only science teacher, at their schools. As we have evolved towards a cohort system, the continuity of teachers enrolled across the six core classes ensures the community grows and flourishes. A subset of teachers in the program have engaged in research projects analyzing the formation of an online community in our program [3].

Finally, we are planning to combine the master's with a teacher certification minor. Expanding the community of practice to pre-service teachers will allow them to interact with in-service teachers over a prolonged period of time, allowing them to mine the collective experiences of teachers from a wide range of backgrounds.

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Dr. Robynne Lock is an Associate Professor of Physics & Astronomy at Texas A&M University-Commerce. She researches physics identity, strategies to recruit students into physics, and gender and is extensively involved in physics teacher preparation.

Dr. William Newton is an Associate Professor of Physics & Astronomy at Texas A&M University- Commerce, specializing in physics education and neutron star astrophysics.

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