Letter from the Chair

Susan Blessing, Florida State University

The Forum on Education is delighted to announce this year’s American Physical Society awards honoring outstanding contributions to education. The 2024 Excellence in Physics Education Award goes to nine members of the outreach team of the Perimeter Institute for Theoretical Physics “for developing outstanding educational resources that are distributed free to physics teachers in 130 countries, for fostering an international peer-to-peer teacher training network, and for delivering inclusive and inspiring educational programs to students around the world.” This team partners with teachers around the globe to develop direct-to-student programs, professional development and resources for teachers, and a peer-to-peer teacher network that stretches across international borders.

The Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction recognizes individuals for outstanding achievement in teaching, sustaining, and enhancing an advanced undergraduate physics laboratory course. The 2024 award is made to R. Seth Smith (Francis Marion University in South Carolina) “for decades of outstanding physics instruction, introducing undergraduates to advanced physics lab topics, for inspiring first-generation students to pursue graduate study and careers in physics, and for working with colleagues in the ALPhA community to improve laboratory instruction nationwide.”

In addition to the two FEd awards for educational efforts, the APS Committee on Education selects recipients of the Prize for a Faculty Member for Research in an Undergraduate Institution and the Award for Improving Undergraduate Education. The 2024 Prize for a Faculty Member for Research in an Undergraduate Institution recipient is Lars Q. English (Dickenson College) “for innovative experiments involving undergraduate students on nonlinear patterns in electrical lattices and networks that have elucidated the interplay of nonlinearity and geometry in the emergence of coherent spatial and temporal structures.”

UC Santa Cruz, Wellesley College, and Worcester Polytechnic Institute shared the Award for Improving Undergraduate Education this year. All three departments showed sustained effort and improvement over at least several years with the participation of a significant fraction of the faculty.

Disclaimer—The articles and opinion pieces found in this issue of the APS Forum on Education Newsletter are not peer refereed and represent solely the views of the authors and not necessarily the views of the APS.
Six FEd members were elected to Fellowship this year:

David A. Craig (Oregon State University) "For serving as a co-chair in the effort to develop and complete the inaugural version of the Effective Practices for Physics Programs (EP3) Guide that is actively aiding physics departments in their work to improve undergraduate physics education."

Michael Jackson (New Mexico Institute of Mining and Technology) "For serving as a co-chair in the effort to develop and complete the inaugural version of the Effective Practices for Physics Programs (EP3) Guide that is actively aiding physics departments in their work to improve undergraduate physics education."

Don S. Lemons (Bethel College of Kansas) "For outstanding work as the author of eight books and dozens of journal articles that distinctly combine a deep understanding of physics and its history, with exemplary pedagogy, and for service as Assistant Editor of the American Journal of Physics."

Marie Lopez del Puerto (University of St. Thomas) "For impactful work on integrating computation into the physics curriculum, for leadership in the Partnership for Integrating Computation into Undergraduate Physics, and for service to the American Physical Society and the American Association of Physics Teachers."

Timothy A. McKay (University of Michigan) "For tireless efforts to catalyze systemic change and make STEM learning environments equitable and inclusive, as well as the use of data and technology to inform and improve STEM learning."

Eric Brewe, the FEd Past Chair, led the selection of our Fellows and awardees. Many thanks to him and Danielle Maldonado, Carlton Pennypacker, Melissa Eblen-Zayas, Amber Stuver, and Carmen Pantoja for their excellent work.

We can’t give out awards unless we receive nominations – please start thinking about next year’s nominations now! Most nominations are due by June 1.

**FEd Sessions at the March and April Meetings**

*Daniel Claes, University of Nebraska-Lincoln*

Whether you are planning to join us at the 2024 March or April meetings, FEd has sessions scheduled with you in mind!

In March (March 3-8 in Minneapolis, Minnesota) FEd will be sponsoring two invited sessions. Advancing Understanding of Physics Retention Using Quantitative Research Methods will share several exciting research strands on improving student success and retention, made possible by the more robust, equitable quantitative instruments the PER field has developed. Many of our departments are facing enrollment challenges (and for some the threat of losing the major altogether). In a session on How Department Are Supporting the Future of Physics we’ll learn how some institutions have leveraged the support provided by national programs, redefined their curriculum, or introduced a new focus on applied areas of physics.

Together with the Division of Quantum Information (DQI) FEd is co-sponsoring a Focus session on Quantum Computing, Education, and Information where talks should motivate discussions on the teaching of core concepts in quantum information and computing, through a variety of pedagogical approaches and media formats, for students of any age or academic level. This session will be opened with a presentation by Bob Joynt (U Wisconsin) who started a Masters program in Quantum Computing, the first in the US, within the Physics department.

We are also hosting two invited Focus sessions in March to honor APS/FEd award winners. R. Seth Smith (Francis Marion University in South Carolina), the recipient of the 2024 Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction, will anchor a special session on laboratory instruction. Lars Q. English (Dickinson College, Pennsylvania) winner of the Prize for a Faculty Member in an Undergraduate Institution, leads off a session on undergraduate education.

Come April we are looking forward to three FEd invited sessions.

A recommendation by the Graduate Student Representative to the FEd Program, a session on Student and Early Career Leadership Mentoring will look at leadership programs incorporated into the PhD Program, professional development for early career scientists, and leadership work focused on mental health and diversity.

Inspired by recently featured collections in The Physics Teacher and the American Journal of Physics on climate change, global warming models, and sustainability issues, including the development of modular units for use in introductory physics classes, FEd has put together a Symposium on Climate Science in the Physics Classroom. Sustainability across the
An Update from the Head of Education

Michael Wittmann, American Physical Society

Hello, colleagues in the Forum on Education!

The APS Education Team supports thriving physics programs by supporting excellent teaching, promoting diversity, equity, and inclusion across graduate and undergraduate programs, developing non-administrative leadership skills in faculty, advancing physics teacher education in physics departments, and helping departments respond to challenges and build on opportunities. Here are a few updates from and about my wonderful colleagues in the Education Team.

I’ll start with the three Education Leads in the team: Erika Brown, Adam LaMee, and Kathryne Woodle.

Erika Brown has stepped into the role of Acting Alliance Director for the Inclusive Graduate Education Network (IGEN) Alliance, an NSF-funded INCLUDES Alliance that brings together multiple professional societies to increase the number of Black, Latinx and Indigenous graduate students to erase the gap in attainment rates by such students between bachelor’s and doctoral degrees. She is also director of the APS Inclusion, Diversity, and Equity Alliance (APS-IDEA). Her recent work is helping take IGEN in new directions, including having the American Mathematical Society join the IGEN Alliance.

APS recently hired Adam LaMee, who is taking on the leadership of our efforts in physics teacher education. He’ll be guiding the efforts of our Physics Teacher Education Coalition (PhysTEC), helping institutions recruit and prepare high school teachers. APS just received a new $3.4M 5-year grant from the NSF to move PhysTEC in a new direction. The project includes efforts by the American Association of Physics Teachers (AAPT), the Knowles Teacher Initiative, and the STEP UP project. Recognizing the need for high school teacher preparation as well as the difficulty in establishing teacher preparation programs, we will work with programs to support teacher recruitment and help institutions work together to provide pathways for more physics students to become teachers.

Kathryne Woodle continues to guide the efforts of the Physics and Astronomy Faculty Teaching Institute (FTI, formerly known as the New Faculty Workshop). I attended the summer FTI workshop, designed by Stephanie Chasteen, Ed Prather, and Rachel Scherr, and it was the best multi-day workshop on physics teaching I’ve ever attended. I’ve led plenty such workshops myself, and none were as coherent, intellectually grounded, well-designed, and meaningful as what I saw. With a growing list of highly skilled facilitators, the value to faculty cannot be overstated. Kathryne also leads the operations of the Effective Practices for Physics Programs (EP3) Initiative - more on EP3 below.

Combining work from multiple projects, a new AIP Venture Fund project will be starting in 2024. Adam and Kathryne are working together with Tom Rice at the American Astronomical Society (AAS) to bring an ongoing webinar series on issues important to departments. Webinars will come from the Equity in Graduate Education group that is part of the IGEN Alliance, the Faculty Teaching Institute, focusing on effective inclusive teaching practices, and the EP3 Initiative, focusing on recruitment and retention. We’re excited to kick this series off!

The three Education Leads and rest of the Education Team are stellar colleagues and collaborators in advancing the next generation of physics at APS. Next up, a few updates for several other projects.

This past summer, Society of Physics Student (SPS) intern Devin Kodsi worked with APS Education Program Manager Christine O’Donnell to complete our annual update of the Education & Diversity Statistics on the APS website. These data let us observe trends about our graduates, helping us understand the
field of physics and who studies it. The updated graphs on the APS Education & Diversity Statistics website now include provisional data from the 2020-2021 academic year published in the Integrated Postsecondary Education Data System (IPEDS). We were particularly anxious to see these data, as they could be the first indications of the impact of COVID on physics and STEM degree rates. Although the total number of physics degrees did decline in the 2020-2021 data, the positive trends in the number of physics degrees awarded to women and students from marginalized races/ethnicities (especially Hispanic/Latino students) continued, albeit at a slightly lower rate of increase. However, diversity in physics is still lower than in many STEM disciplines, including chemistry and engineering. You can view our collated data here (https://www.aps.org/programs/education/statistics/) to learn more.

The Effective Practices for Physics Programs (EP3) Guide at ep3guide.org continues to grow! The newest EP3 Guide section is How to Select and Use Various Assessment Methods in Your Program (https://ep3guide.org/guide/how-to-select-and-use-various-assessment-methods). It’s an incredible resource for people who want support when assessing students, and also when assessing classrooms, courses, and programs. The section provides guidance on tools such as surveys, inventories, and classroom observation to measure program outcomes and develop a better understanding of departmental strengths and areas for growth. The section guidance, along with its supplemental materials on key performance indicators; survey, interview, and focus group design; and data analysis, visualization, and interpretation, will help ensure that your assessments are actionable.

Finally, as the EP3 Initiative moves from being an NSF-funded project to being sustained by the physics community with support from APS and AAPT, we have spent the past year with an EP3 Editorial Board developing its policies and procedures to ensure the future of the living document that is the EP3 Guide. At the end of the year, editorial board co-chair Mike Jackson and member Gubbi Sudhakaran will step down, and two new members will be elected by the APS Committee on Education.

The next area for EP3 to grow into is the support of graduate education. So far, the Guide has focused on undergraduate programs. Supported in part by new NSF funding through the Inclusive Graduate Programs in Physics and Astronomy project, we will be developing new materials for the EP3 Guide.

Exciting times! We’ll have more to report for the next newsletter.

APS Partners with Physics Groups to Educate Members on Anti-DEI Legislation

_Tawanda W. Johnson, American Physical Society_  
_Julie Davis, American Physical Society_

During the last two years, state-level legislation seeking to limit or ban diversity, equity, and inclusion (DEI) offices, programs, and policies has proliferated across the country, causing the physics community to become concerned about possible negative impacts on their research, teaching, and DEI activities.

To educate their members on how to navigate these policies, APS, the American Association of Physics Teachers, and the National Society of Black Physicists recently sponsored two informational webinars on the topic. Two experts – one in Florida where some of the first and most extreme pieces of anti-DEI legislation have been passed and one covering the topic nationally – helped explain and contextualize the issue. They stressed to members that while the laws may seem intimidating, most DEI work can continue.

Katheryn Russell-Brown, a law professor at the University of Florida, provided an overview of specific provisions of Florida’s SB 266, which took effect July 1, 2023. It has raised a lot of questions about the future of DEI activities in Florida, as well as race and gender topics in curricula and recruitment.

Jeremy C. Young, program director of Freedom to Learn at PEN America, the professional society for writers, reported during his talk that, since January 2021, there have been 99 proposed anti-DEI bills in 33 states. Twelve anti-DEI laws and restrictions have passed in nine states, affecting 73 million Americans. He explained that those laws impact student teaching, teacher training, and higher education.
However, Young emphasized that these laws are often vague and difficult to enforce, relying instead on a “chilling effect” created by educators and DEI professionals voluntarily changing their curricula or ceasing their DEI work. He noted that there have been few disciplinary cases under these laws, and that he is unaware of any scientist who has faced disciplinary measures.

In light of the reality surrounding these laws, both Russell-Brown and Young offered suggestions on how members can think about the policies, work with their institutions, and advocate for change.

Russell-Brown’s recommendations include presenting one’s program idea in writing to the department chairs and deans to ensure that it complies with SB 266. She also suggested that people request guidance from university administrators, use existing programming at their institutions as a guide, and inform their colleagues of their programming and curricula plans.

Young stated that educators shouldn’t do the censors’ work for them. Instead, he said to avoid over compliance. Citizens should tell the story of higher education and democracy by writing op-eds and letters to the editor, and talking with family and friends about the laws. Additionally, Young recommended that professionals engage in coalition building. Lastly, he said that everyone should develop convincing arguments about the laws, including how they are having a chilling effect on free speech.

View the webinars on APS’s YouTube channel:

Florida
Across the United States

Tawanda W. Johnson is the Senior Public Relations Manager at APS.
Julie Davis is a Federal Relations Senior Associate at APS.

Physics and Astronomy SEA Change: 3 Years Later and Going on Three Cohorts

Alexis Knaub, Director of Physics and Astronomy – SEA Change, American Association of Physics Teachers

Since my last article for the FEd newsletter (https://bit.ly/FEdFall2020), a lot of great things happened in the Physics and Astronomy (P/A) SEA Change. SEA = STEMM (two M’s- one is for “medicine”) Equity Achievement (SEA).

What is SEA Change?

P/A SEA Change is the first disciplinary award pilot, a collaboration among many physics and astronomy professional societies, and in partnership with the American Association for the Advancement of Science (AAAS). The goal is to support continual, data-informed systemic change regarding equity, diversity, and inclusion (EDI) in postsecondary STEMM education; AAAS SEA Change focuses on institutional level change, while P/A SEA Change is tailored for physics and astronomy departments.

The SEA Change process entails undergoing a comprehensive self-assessment regarding all populations in the department, paying particular attention to race, gender, and the intersection of race and gender. The self-assessment includes questions around policies and procedures as well as culture and climate. Both qualitative and quantitative data are encouraged. The self-assessment supports the creation of a 5-year action plan that addresses some of the issues and leverages some of the opportunities; the action plan must have specific steps and metrics to demonstrate how an issue will be addressed. The self-assessment is also used to create a narrative that explains what was learned and how they made choices for their action plan. The narrative and action plan are part of the application for a Bronze-level award. A review panel provides feedback. Awardees work on their five-year action plans, with regular check-ins. At the end of 5 years, they can reapply.

What departments have done, thus far

This is not a one-size-fits-all approach, given that departments can be incredibly different when it comes to resources, challenges, etc. To ensure that this process is doable for many types of departments, we have launched two pilot cohorts. Pilot cohort 1 began on 3 May 2021, and pilot cohort in winter/spring 2022. We have engaged with 11 departments (5 in cohort 1, 6 in cohort 2) ranging in size, type, location. Due to confidentiality, we cannot reveal who is in these cohorts. Each cohort meets about every other month to discuss progress, challenges, etc.

Change work is often slower than anticipated. As many of you may empathize, the departments are experiencing considerable challenges that slow down change work. The Covid-19 pandemic has still been very much impacting the departments. Multiple departments have seen changes in key departmental and institutional leadership, along with financial challenges and state and federal level decisions that impede EDI work. Still, the departments are engaging with this P/A SEA Change work. I am grateful that they are so dedicated to improving their departments for all, despite the number of issues occurring currently.

At the end of May 2023, we received our first Bronze-level application. Other departments are still making steady progress,
and we anticipate some of the other departments will apply for a Bronze-level award in the upcoming months.

What P/A SEA Change and AAAS have been up to

As mentioned previously, P/A SEA Change is the first disciplinary award pilot for SEA Change. Although we have learned a lot from AAAS SEA Change, the P/A SEA Change Committee has been designing our processes and procedures to ensure this is a fair and relevant process that truly advances EDI in physics and astronomy. With our first Bronze-level application, we are testing the processes we have designed for reviewing applications and supporting departments in implementing their action plans. We hope that our approach will be useful for other disciplines designing their own disciplinary SEA Change.

In addition to working with the pilot cohorts, we have been running webinars featuring promising practices that physics or astronomy departments might undertake. The playlist is here (https://bit.ly/SEAChangeWebinars). Webinars are free for anyone to attend if they sign up. For upcoming webinars and other news, we have mailing list and send out monthly updates (https://bit.ly/SEAChangeUpdates). Interested individuals can also join the AAAS SEA Change Port of Call Community (https://bit.ly/SEAChangePortOfCall), which is free to use for most parts.

We have also been attending professional society meetings (virtual and in-person) for P/A SEA Change. Our activities include sharing updates with the broader physics and astronomy community as well as recruiting and just generally, good conversation regarding EDI, physics, and astronomy.

As P/A SEA Change is moving out of the pilot phase, AAAS SEA Change and P/A SEA Change have been working on our next steps. AAAS SEA Change received an NSF Creativity Extension in September and included P/A SEA Change as a subawardee. I am now the Director of P/A SEA Change.

Smith College Physics earned the Bronze Award

We are excited to announce our first Bronze Award recipient, the Smith College Physics Department! The press release is here (https://bit.ly/SmithBronzeAward). This has been important milestone for the program, and the P/A SEA Change Committee congratulates their department for persisting in the SEA Change process.

Seeking departments for cohort 3!

With the good news of additional funding, we are recruiting for our next cohort. If your postsecondary physics or astronomy department is interested, please fill out this form (https://bit.ly/SEAChangeCohort3) by 22 November 2023. If you have questions, please email me at aknaub@aapt.org.

P/A SEA Change has been generously funded by the AIP Venture Partnership Fund.

Responding to an Enrollment Crisis by Focusing on Retention and Recruitment

Michael Wittmann, American Physical Society

A crisis in enrollment is already happening in physics, but departments can do something about it! APS wants to support departments to prepare for what’s coming next through initiatives like the Effective Practices for Physics Programs (EP3) Guide, which has practices and strategies that departments can use right now to prepare for what’s coming next.

According to data collected from colleges and universities by the federal government and presented by APS, graduation rates for students with Bachelor’s degrees and PhD’s have been dropping since 2021. This comes after decades of growth in the field.

Importantly, these trends precede the Covid-19 pandemic. Already in 2019, data showed dropping enrollments in colleges. Unfortunately, the pandemic has only exacerbated the situation. Where once roughly 70% of high school graduates attended college or university, the numbers since the end of the pandemic are closer to 62%. And, starting in 2025, we will reach
the "demographic cliff," with fewer students graduating high school, an effect of the recession of 2008-2009.

These problems are not unique to four year institutions. Enrollment at community colleges (or two-year colleges) are a common pathway to a college or university for many students in many states. There are already millions fewer community college students than in 2010. After 3 consecutive years of substantial drops in enrollment during the pandemic, enrollments have only barely risen in the past year.

Looking forward to the late 2020s and early 2030s, we can consider the consequences of standardized test data from the National Assessment of Educational Progress (NAEP) and Northwest Evaluation Association (NWEA). Both show the negative effects of the pandemic on children in fourth and eighth grade. Last year’s eighth grader might be applying to college in 2027; last year’s fourth grader might be considering college in 2031. NWEA data show students 1/3 to 1/2 of a year behind their peers from years past, in terms of performance on both reading and math tests. These results are exacerbated for students from marginalized groups.

As faculty, we should already be paying attention to the needs of students entering our institutions, helping them succeed in our courses. For both our majors and our non-majors, we should be creating learning environments that help them learn the physics and thrive, serving as a “pump” and not a “filter,” to use a common metaphor. Students a half year behind in their education in early grades may struggle as they enter high school, especially with the mathematical reasoning that is needed for success in science courses. Many may not choose to go to college. Of those that do, a major in a mathematical science like physics may be daunting. Yes, junior high schools and high schools are doing an incredible job in responding to the pandemic, but we as faculty need to plan ahead and modify what we are already doing to best support these students in 4 to 8 years. How we respond to the needs of our students and adjust to the skills they arrive with will play a large role in whether they choose our major and stay in it.

We know that student enrollment is already causing problems for departments. In a survey carried out by the EP3 Initiative in 2022, over 70% of departments named low enrollment as a major concern. So what is a department to do?

Several options exist. Departments must ask and then answer the question of how to recruit and how to retain the students you have. Why physics? What is the compelling story? Keeping the students already in your courses and in your major is as important as recruiting new ones!

The EP3 Guide has extensive advice, with practices and strategies for both recruiting students and retaining students, as well as a goal map to help navigate the many other areas that affect student retention and help recruit students: advising and mentoring; making changes to introductory courses, to upper division courses, and to laboratory instruction; defining new degree tracks; modifying the capstone experience; and creating opportunities for undergraduate research. The EP3 Guide also has guidance on talking about careers in physics, which serves as a powerful recruiting tool (“what can you do with this major?”) and as a retention tool (“look at this great job I can get!”).

It also helps to pay attention to who your majors are. Nationwide, the number of Hispanic/Latine students has been going up since the early teens, and we should encourage this trend. More broadly, the number of students from all marginalized communities in the US has been growing since the early teens. In particular, the number of women in physics rose strongly through the late teens, only dipping slightly in the past year or two. As enrollment trends show that women are enrolling in college more than men, we need to address issues of culture to make the physics major more welcoming to women and other marginalized students.

We can’t stick with the old ways if the old ways don’t lead to success. A department with high enrollment that is not equitable is not yet, in my mind, a success - it’s merely a department with a lot of students. Creating a department that is welcoming to and supportive of all students takes work - and again, the EP3 Guide has supports in the form of a section on equity, diversity, and inclusion as well as departmental culture and climate.

For some departments, these suggestions may come too late. If your department is already under threat (or close to being so), turn to the Toolkit for Departments Under Threat, with suggestions for what to do right now and also in the near future. If your department isn’t yet under threat, start the work of increasing your enrollment by turning to the EP3 Guide and preparing for what is coming in the next decade. With enrollments being of such concern across campuses nationwide, resources such as the EP3 Guide are designed to help you!

As the data at the beginning of this article indicate, the numbers of students attending college will continue to go down, and it’s up to the faculty in our departments to respond. The physics major needs to be more than an offshoot of the service courses that most departments teach. It needs to be placed centrally as a major concern across campuses nationwide, resources such as the EP3 Guide are designed to help you!

Michael Wittmann is the Head of Education at APS.
Diversity of Two-Year College Students

The breadth of diversity of students at two-year colleges is undeniable. Of the 4.7 million students attending TYCs, over half (2.8 million) are women.1 Community college students tend to be older than those at four-year institutions, with 31% of students over the age of 24, and 68% of students attending college part-time.2 Student populations at TYCs also include higher percentages of those students who are historically underrepresented in higher education, as shown in Figure 1. At public TYCs, 40% of enrolled students are Black or Hispanic, compared to 32% at public four-year colleges and universities.3 Students at TYCs are also more diverse in other ways compared with four-year colleges and universities, as shown in Figure 2. These include TYCs supporting more first-generation college students,4 students with dependent children,5 military veterans,6 and students with disabilities.7

Students choose to enroll at a TYC for a variety of reasons beyond earning an Associate’s Degree or Certificate,8 these include: gaining professional development and career skills, transferring to a Bachelor’s program, and personal interest. For example, some students may require a physics course to qualify for a doctoral program in physical therapy; these students have already obtained an undergraduate degree, and are attracted to a flexible, low-cost alternative to fulfill their program prerequisites. Additionally, dual enrollment programs that bring in high school students to college courses are increasing.

Students in TYC Physics Classes

In Fall 2020, 51% of all students enrolled in public institutions of higher education were enrolled in community colleges.9 According to the AIP Statistical Resource Center, in 2017-2018, students who started at a community college represent 16% of US citizens receiving physics PhDs,10 and 15% receiving physics bachelor's degrees.11

While the number of physics majors in two-year college physics classrooms is very small, the impact of TYC physics on STEM education in general is significant. The National Center for Science and Engineering Statistics reports that in 2019, 45% of all science and engineering graduates attended a community college.12 Looking at the health professions, broadly including medicine, pharmacy, veterinary medicine, dentistry, and similar programs, 13.5% of professional degree holders in clinical practice, 21.5% of doctoral research degree holders, and 26.3% of master’s degree holders in health and clinical sciences started at a community college.13

TYC Faculty Work and Goals

Faculty at two-year colleges are teaching-focused. While class sizes are small (typically 20-30 students per section), the teaching load is high compared with four-year institutions. For instance, TYC faculty often teach five classes per semester. There are no assistants for grading, and very few TYC faculty have lab support. Thus we are responsible for not just being in the classroom, but also all of the grading, setting up instructional laboratories, procuring and maintaining equipment, and mentoring students.
While some TYCs provide funds for professional development, most do not. Thus, traveling for a conference or workshop can be financially prohibitive. Approximately 60% of TYCs offering a physics class have no or one full-time faculty member teaching it,\(^1\) so finding a substitute instructor to cover absences for professional development is often unlikely.

On the other hand, having a small number of colleagues and students allows for easier pivots to pedagogical changes.

**TYC Faculty Needs**

In 1989, a conference for two-year college physics-teaching faculty members identified five critical issues that we face: (1) a sense of isolation; (2) difficulty networking with peers and/or mentors; (3) a lack of professional development opportunities; (4) a lack of data on TYC students and their learning; and (5) a lack of data on faculty, programs, and institutions.\(^5\) Add to this the greater diversity of students attending TYCs than at four-year institutions, there is clearly a need for TYC instructors to better support a wide range of STEM students.

Past grant-funded projects have worked to address some of these critical issues. Indeed, the idea for a national center for TYC physics emerged during the 1990s. Champions from the TYC physics community leveraged grant funding to help the community towards this end.

However, as the small number of leaders moved on or retired, they have left a void in the TYC physics community and a gap in training and opportunities dedicated to TYC faculty.

**The Organization for Physics at Two-Year Colleges (OPTYCs)**

To rebuild the community, coach future leaders and champions, and provide relevant professional development opportunities, a virtual and national center for physics at two-year colleges has been founded. The Organization for Physics at Two-Year Colleges (OPTYCs) is a four-year NSF-funded initiative supported by the American Association of Physics Teachers. The OPTYCs team consists of four project co-directors (Robert Hilborn, Dwain Desbien, Sherry Savrda, and Kris Lui) and nine program coordinators (Krista Wood, Tom O’Kuma, David Marasco, Renee Lathrop, Joe Heafner, Brooke Haag, Anthony Escuadro, Karim Diff, and Abigail Daane). We benefit from a five-member advisory board (Eric Baer, Geraldine Cochran, Anne Cox, Alexis Knaub, and Todd Leif).

Addressing each of the critical issues above, OPTYCs offers a wide variety of programs and is funding some studies. Here is a brief overview of our proposed deliverables:

- Continuing Professional Development Workshops (most are virtual, free, and open to everyone; some have been offered at AAPT national meetings)
- Physics Education Research (PER) Interest & Facilitation (activities and discussions aimed at bringing more awareness of PER to the TYC community and expanding the scope of PER to be inclusive of TYC populations, both as subjects and as researchers)
- Mentoring & Networking Program (for traditional mentoring pairs, horizontal/mutual mentoring groups which have been effective in reducing isolation, and affinity groups or learning communities for topic-specific or time-limited projects)
- New Faculty Development Series (intensive program designed for new or aspiring TYC physics and astronomy faculty members)
- Leadership Institute (artisanal guided program to aid faculty in project development and implementation)
- DEI Capacity-Building Program (an immersive experience to initiate and sustain lasting positive change in our classrooms and environments)
- The TYC Physics Program Guidelines complete revision (published in 2000)
- American Institute of Physics Statistical Research Center comprehensive survey of TYC physics and astronomy programs, courses, faculty, and students (the last survey on TYC physics was completed in 2011)
- Digital repository of resources, archives, and asynchronous professional development
- TYC Tandem Meetings (one-day conferences held in conjunction with the AAPT national summer meeting)

**You Are Invited**

To be sustainable, it is not enough for OPTYCs to offer these professional development opportunities and relevant resources for TYC physics and astronomy; members of the TYC physics community must first learn of the existence of OPTYCs, then engage in various opportunities, and ultimately take leadership roles by facilitating workshops, coordinating programs, and helping to find funding sources. Furthermore, sustainability involves being recognized and valued as part of the larger physics community, beyond that of TYCs. This includes four-year faculty, high school teachers, industry professionals, government scientists, and beyond.

You can help! Visit our website (https://optycs.aapt.org/) Register for a virtual workshop or discussion. Tell your colleagues. Reach out to your local two-year college physics and astronomy faculty for conversation and collaboration. Subscribe to our newsletter, *Spotlight*, and our YouTube channel. Complete our annual participant survey. All of these things will help showcase the talent and energy that TYC faculty have, and the relevance for OPTYCs to the vast physics ecosystem.

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References:


Alma Robinson, Virginia Tech

Jeff Rozelle, the CEO and President of the Knowles Teacher Initiative, describes how the Knowles program supports early career high school math and science teachers through mentorships, professional development opportunities, and classroom equipment. Remarkably, Knowles Fellows can benefit from over $50,000 in financial support during their five-year fellowship. Knowles will be partnering with PhysTEC to give PhysTEC graduates more opportunities for professional development and teacher communities. I hope this article inspires you to inform your preservice teachers about the Knowles Teaching Fellows Program.

The Next Generation Science Standards (NGSS) have included engineering design practices as part of their guidelines for K-12 science instruction. To implement these standards, many schools integrate these practices into existing science curriculum, rather than offering standalone engineering classes. Leslie Atkins and ShaKayla Moran describe a research methods class at Boise State University that authentically engages their science preservice teachers in these engineering design practices so that they can learn about the nature of science and how to create genuine scientific and engineering experiences for their future students.

Knowles Teacher Initiative: Support for New Physics Teachers Available

Jeff Rozelle, CEO and President of the Knowles Teacher Initiative

Established in 1999 by Janet H. and C. Harry Knowles, the Knowles Teacher Initiative is a nonprofit organization that supports a national network of mathematics and science teachers who are collaborative, innovative leaders improving education for all students in the United States. Through the Knowles Teaching Fellows Program, Knowles supports early-career, high school math and science teachers in their efforts to develop teaching expertise and lead from the classroom. Through the Knowles Academy, Knowles provides professional development services for teachers and customized services for schools and districts that are designed and facilitated by experienced teachers.

Knowles is incredibly excited to be partnering with PhysTEC on their new NSF supported grant. Our founder was a physicist, and the future of physics teaching and physics teachers in the US was a driving factor in the development of his foundation and our work. As part of the grant, Knowles will be providing recent PhysTEC graduates with online professional development designed and led by Knowles Senior Fellows who completed our Teaching Fellowship program. This opportunity to support PhysTEC’s desire to build community among new physics teachers matches well to our long-standing support of teacher professional community and growth.

Knowles is also currently recruiting for the 2024 cohort of Knowles Teaching Fellows. While new teachers are going through a certification or licensure program, they are often surrounded by a cohort of other new teachers and have dedicated mentors that are with them in their classrooms almost all the time. In addition, because they are usually connected to college campuses, they typically have access to many resources, including journals, experts, classroom materials, and classrooms. We’ve found that the first few years of teaching, then, can be jarring for new teachers. Often, they have a sense of isolation as they navigate their new school environment. Mentoring programs provided by their schools and districts aren’t always as supportive or comprehensive as they need to be. Schools often lack the capacity to offer new teachers the necessary professional development opportunities and physical classroom materials needed to realize their teaching vision and create their desired classroom environment. While they are attempting to learn a challenging new profession, they find themselves under-resourced.

The Knowles Teaching Fellowship was designed specifically to address some of the challenges faced by new high school math and science teachers to help them thrive as new teachers and become teacher leaders who are able to support other teachers and improve math and science education for all students. The Knowles Teaching Fellows Program is a five-year program that supports early-career, high school mathematics and science teachers in their efforts to develop teaching expertise and lead from the classroom. Each year, we award approximately 35 Fellowships to new math and science teachers who have outstanding content knowledge in math or science, are committed to becoming great teachers, and possess potential to become the kinds of teacher leaders who make a difference in schools.
We built our Fellows Program on a cohort model that allows Fellows to connect with peers who are at roughly the same point in their teaching careers. And as our Fellows finish the Teaching Fellows program, they tell us that there has been no greater professional support than the cohort of teachers who go through the Fellowship with them.

Knowles Teaching Fellows receive a comprehensive array of benefits that are designed to support new teachers and emerging teacher leaders. We support Fellows financially by offering grants to cover expenses associated with purchasing classroom materials and engaging in professional development. Fellows are eligible to request funds to develop and execute leadership activities that have an impact beyond their own classroom. In addition to the grants, Fellows are eligible to receive stipends. We recognize that our Fellows (and this may be most true for physics graduates) are highly accomplished and have other choices available to them for careers. These stipends allow them to reduce debts they may have incurred and reduce the financial burden teachers often bear—both of which are factors that contribute to sustainability in the profession. Alternatively, stipends can be used to support Fellows financially during the summer months, allowing them to concentrate on reflecting on the past year, preparing for the coming year and professional development rather than taking on a part-time job during the summer as many teachers need to do. In total, Fellows are able to access more than $50,000 in financial support over the five years of the Fellowship.

We’ve opened the application for our 2024 Teaching Fellowship. Prospective applicants must meet the following eligibility requirements:

- Applicants must have recent knowledge of the content they intend to teach. Specifically, applicants must have earned a related degree between 2014 and Sept. 1, 2024.
- Additionally, applicants must have earned a secondary certification somewhere between January 1, 2019, and September 1, 2024, with the goal of teaching full time in a high school science or mathematics classroom no later than the fall of 2024.
- Last, the Fellowship is intended to support teachers who are 1st, 2nd or 3rd year teachers during their first year of the Fellowship (August 2024). That means, currently, we’re recruiting people who are student teaching or are first and second year teachers.

If potential applicants have any questions regarding eligibility, they can send their inquiry to apply@knowlesteachers.org and we’ll be sure to reply quickly. To apply, applicants can be directed to www.knowlesteachers.org/KnowlesFellowship where they can get all the information they need.

Finally, Knowles is always happy to do presentations (either by staff or, if possible, Fellows) in methods classes or at other events arranged for new teachers. That can be arranged by reaching out to me (jeff.rozelle@knowlesteachers.org) or by contacting apply@knowlesteachers.org.

Jeff Rozelle has served as the President and CEO of the Knowles Teacher Initiative since 2022. Prior to joining Knowles in 2013, Jeff was an assistant professor of science education at Syracuse University where he coordinated the secondary science certification program. Jeff taught high school chemistry and biology in Cincinnati Public Schools for 9 years.

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**Engineering Design in Physics**

*Leslie Atkins and ShaKayla Moran, Boise State University*

The interplay of phenomena, modeling, experimental design, and analysis

In Newton’s “New Theory of Light & Color,” published in 1671/2 (Newton, 1993), he begins by describing a puzzling phenomenon: when sunlight passes through a pinhole and then a prism, it forms an oblong and colorful image. This differs from the circular image of the sun that Snell’s Law predicts. In subsequent pages, Newton explores potential explanations for this image: whether the sun’s angular width might be a factor (a possibility he eliminates empirically); if the light’s path curves within the prism, akin to the motion of a spinning tennis ball (also dismissed); or if irregularities in the glass are influencing the shape or colors (refuted by introducing a second prism in sequence, which effectively “undoes” the effects of the first prism).

Finally, he describes an experiment in which he projects the spectrum onto a screen that has a small aperture, allowing only a narrow slice of the spectrum to pass through. This selected color is then refracted once more in a second prism, without further separation into additional colors. With this, he argues that white light is made of rays that are “differently refrangible,” and that the color of a light ray is related to how refrangible that ray is. Furthermore, he notes, attempts to make a lens that has no chromatic aberration is futile; telescopes should use reflection instead.

Throughout, we see Newton moving between articulating a puzzling phenomenon, developing models to explain that phenomenon, designing experiments to interrogate those models, and making claims about light and color that result from that model. He does not so much “make” an observation or “collect” data, but actively designs experiments and builds artifacts to produce the observations and data he needs. In this way, scientific advancement not only lays the foundation for advancing engineering (as with the telescope), but engineering design is essential for advancing scientific ideas (as seen in Newton’s empirical designs).
Physics as an opportunity to introduce engineering design

The Next Generation Science Standards (NGSS Lead States, 2013), which has been adopted by 20 states and informs the science standards in many others, set guidelines for science instruction across K-12. This most recent set of standards includes, for the first time, engineering design practices. These include defining problems, designing solutions, evaluating those solutions based on prioritized criteria, and optimizing solutions.

Most K-12 schools meet those engineering standards – if they have capacity to address them at all – not by offering engineering courses but as units added to existing courses with classroom teachers (in primary school) or science teachers (in secondary school). College science courses for preservice teachers, therefore, should consider offering instruction in engineering design when possible. Doing so not only gives preservice teachers experience with the engineering standards, but, as seen in the example from Newton, has the potential to improve science instruction as well, offering a more authentic model of scientific practice. This broadens our understanding of what it means to be “doing science,” emphasizing that a diverse set of skills and interests are vital to the scientific community— skills that go beyond end-of-chapter problem solving. This is particularly critical for future teachers who are tasked with recognizing and developing these skills in their students.

At Boise State University, with funding from NSF grant 1712051, we have been exploring where opportunities for design emerge during students’ scientific inquiry, and what kinds of activities support engagement in engineering design practices while also advancing scientific ideas. Below we offer a brief example of one design project undertaken in our class, with a sketch of how scientific modeling and argumentation can feed into engineering design.

The course, and a design project

The course described here is a research methods course for future secondary science teachers; we have a similar course for preservice elementary teachers as well (and we are running a high school course this semester). Versions of the course have been described in further detail in Atkins Elliott, Jaxon & Salter (2016) and Salter & Atkins (2013). We begin with a complex phenomenon (e.g., a pinhole camera, an analemmatic sundial, etc.) and, over several weeks, develop models that account for that phenomenon. Students often generate competing models, and this is fertile ground for defining, solving, and improving an engineering design challenge to select between models. As those challenges emerge, we address them more systematically, with design skills as a learning outcome in their own right, while also supporting a nuanced understanding of scientific ideas.

One semester, focused on energy, students began with the “Gauss rifle” — an arrangement of magnets and balls that accelerates one ball at a great speed. It can seem, at first glance, to violate energy conservation. In modeling the energy in this system, groups disagreed on the origin of this “excess” energy. One model predicted that the ejected ball must have the same speed as the incoming ball. In another, the ejected ball must be faster than the incoming ball. Measuring the speed of the incoming ball proved challenging; it accelerates rapidly over a very short distance and familiar tools failed to capture this (students were not familiar with the ballistic pendulum). Ultimately, as we precisely defined the problem we were solving, students recognized that we did not need to determine the speed itself, just whether or not the speed changes. After considering and prototyping a few options, they designed and built a 3-d printed ridged surface and recorded the sound of the incoming and exiting ball as they rolled across, analyzing the sound to determine if the speed was appreciably different. (If anything, the ejected speed was slower, adding weight to the model in which the kinetic energy in the ejected ball was provided by the incoming ball.)

Discussion

Assigning students the tasks of articulating, solving, and improving these design challenges is frequently more than just a brief lesson or homework. The process of design becomes the central focus of our activities, often spanning a week or more. Granting students the autonomy to tackle these problems may lead to unexpected equipment and material requirements. It’s not unusual for students’ designs to encounter repeated setbacks. In other words, meaningfully engaging in engineering design may come at the expense of other learning outcomes. For our students and the objectives of our course – which include design standards and the nature of science – we find that the trade-offs are well worth the cost.

Leslie Atkins is a Professor of Curriculum, Instruction & Foundational Studies at Boise State University, where she focuses on STEM teacher preparation. She received her PhD in physics from the University of Maryland.

ShaKayla Moran earned a BS in Biology and a Master’s in Education from Boise State University. She works for Boise State TRIO Upward Bound where she helps traditionally underserved high school students navigate complex educational spaces. Her research focuses on parallels between the design of physical artifacts in engineering and the design of concepts in science, with an interest in the role of language in student’s construction of scientific knowledge.

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Upcoming newsletter deadlines:

Spring 2024: February 1, 2024
Fall 2024: October 15, 2024