APS Forum on Education FEd

Spring 2026 Newsletter
Alessandro Cunsolo, Editor

Letter from the Chair-Elect and Past Chair

Geraldine L. Cochran, *Past Chair of FEd, The Ohio State University*

Tino Nyawelo, *Chair Elect of FEd, The University of Utah*

Dear Members of the APS Forum on Education,

We write to you to begin a discussion on both the essential contributions and the ongoing challenges faced by **VITAL** faculty (**V**isiting, **I**nstructors, **T**emporary, **A**djunct, and **L**ecturers) within the physics community.

VITAL faculty play a central role in the university teaching mission. Their contributions extend well beyond classroom instruction to include the design and implementation of specialized programs, curriculum development, and extensive student advising and mentorship. Despite these significant responsibilities, they are often underrepresented in departmental decision-making processes, including hiring and curriculum planning.

At the same time, many VITAL faculty carry heavy teaching loads, often three to four courses per term, including large introductory lectures and laboratory sections. These demands leave limited time for instructional innovation, and professional development. In addition, constrained funding and insufficient institutional support can make it difficult to attend conferences or engage in professional growth opportunities. As a result, many feel only partially integrated into the broader physics community, including within APS.

The APS Committee on Education—including representatives from FEd—recognizes these challenges and has established a working group to better understand how APS can more effectively support this community. Ongoing discussions have focused on expanding professional development opportunities, increasing recognition, improving representation in APS activities, and addressing structural barriers to participation. Strengthening connections with VITAL faculty is not only a matter of inclusion and recognition—it is essential to advancing high-quality physics education.

Tino Nyawelo. Until recently, I, Tino Nyawelo, a non-tenure-track faculty member in the Department of Physics & Astronomy at the University of Utah, shared many of these perspectives. I did not fully recognize the value of APS membership until 2025, when I joined the APS Forum on Education (FEd) Executive Committee as Vice Chair. Through this experience, I came to appreciate that APS provides meaningful opportunities for professional growth, recognition, and community—opportunities that are especially valuable for teaching-focused faculty, whose institutional roles may otherwise limit access to such resources.

I am deeply grateful to Geraldine Cochran for encouraging me to run for the APS Forum on Education Executive Committee. I now serve as Chair-Elect of FEd, where I oversee the Programming Committee responsible for selecting invited sessions for both the APS March Meeting and the April Meeting (Global Physics Summit 2027).

In this role, I have also had the opportunity to participate in APS's 2026 Congressional Visits Day (CVD), where I advocated for the importance of federal funding for science and engaged with elected officials in Congress on policies affecting the physics community.

APS offers valuable opportunities to connect with peers, share best practices, and gain visibility through presentations, committee service, and leadership roles.

Engagement with APS has strengthened my professional identity, advanced my career, and amplified the voice of teaching-focused faculty within the broader physics community. Increasing awareness of these benefits is essential, as many non-tenure-track faculty may not yet see APS membership as directly relevant to their roles—but it is

Geraldine L. Cochran. Before starting my current position at The Ohio State University, I was a non-tenure-track faculty member in the Department of Physics & Astronomy at Rutgers University on the professional practice track. During that time, I considered APS one of my main professional homes. In 2021, I completed a sabbatical at APS, where I learned more about the structure and function of the organization in supporting physicists at all levels.

Thus, I believe the initiative started by the APS Committee on Education (COE) is incredibly important. I encourage all VITAL faculty—and those interested in supporting them—to respond to the COE survey linked in Mila Kryjevskaia's letter, and to support FEd and COE's efforts to center the needs, support, and valuable work of VITAL faculty.

Note: This survey also contains questions related to the COE Focus Areas and other topics of interest, as discussed in detail in the letter by Mila Kryjevskaia

https://ndstate.co1.qualtrics.com/jfe/form/SV_026z74mDBDN1KZM

From the Chair

Clausell Mathis II, *Chair, APS Forum on Education*

Dear Members of the APS Forum on Education,

It is an honor to serve as Chair of the APS Forum on Education (FEd). I am grateful for the leadership of those who have guided the Forum before me and for the dedication of our Executive Committee and members who continue to strengthen physics education across all educational settings.

Physics education is at an exciting moment. As our field evolves, so too do the opportunities and challenges we face. Whether we are preparing future physicists, supporting K–12 teachers, improving undergraduate instruction, advancing physics education research, or expanding participation in the discipline, our collective work shapes the future of physics.

This year, FEd will continue to focus on building connections across the physics education community. We hope to provide meaningful professional development opportunities, foster dialogue among educators and researchers, highlight innovative teaching practices, and create spaces where diverse perspectives can inform the future of physics education. We also remain committed to supporting educators across institutional contexts, including K–12 teachers, teaching-focused faculty, and those working in emerging areas of physics education.

Our strength as a community comes from the willingness of our members to share ideas, mentor one another, and contribute their expertise. I encourage you to become involved—submit newsletter articles, propose conference sessions, nominate deserving colleagues for awards and APS Fellowship, participate in our webinars, and share your perspectives on the issues that matter most to you.

Thank you for your continued commitment to advancing physics education. I look forward to working together as we continue building a welcoming, innovative, and intellectually vibrant community for all who teach, learn, and care about physics.

Sincerely,

Clausell Mathis II
Chair, APS Forum on Education

From the Past Chair

Geraldine L. Cochran, *Associate Professor of Physics, The Ohio State University*

Celebrating Outstanding Contributions: 2026 FEd and COE Awards

As the Past Chair of FEd, I have the pleasure of writing in celebration of those who have been recognized for their contributions to education. This year, FEd and COE are proud to highlight the following 2026 recipients:

Excellence in Physics Education Award

This award recognizes a team, collaboration, or, in exceptional cases, an individual who has exhibited a sustained commitment to excellence in physics education.

Theodore Hodapp (Gordon Betty Moore Foundation), 2026 recipient. For leadership in the development and implementation of outstanding physics education programs that have led to sustainable, systemic changes in the teaching and learning of physics at all levels with a focus on broadening participation and making physics more accessible to all.

Award for Improving Undergraduate Physics Education

The COE recognizes improvement in undergraduate physics education and supports effective practices in education at the undergraduate level with the COE Award for Improving Undergraduate Physics Education. This year two departments were recognized for their efforts.

Amherst College For revitalizing its astronomy program, fostering an inclusive and collaborative departmental culture, and achieving significant growth in student enrollment through sustained curricular and community-focused initiatives.

Morgan State University For integrating student-centered pedagogy in small classes, providing early research exposure, and connecting classroom learning with professional development.

The following awards and prizes are administered through FEd.

Reichert and Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction

This award is to recognize and honor outstanding achievement in teaching, sustaining (for at least four years), and enhancing an advanced undergraduate laboratory course or courses at U.S. institutions.

John Essick (Reed College), 2026, recipient. For sustained leadership and innovation in advanced laboratory instruction, for developing influential curricular materials, and for nurturing the success of students and of colleagues throughout the advanced laboratory community.

Prize for a Faculty Member for Research in an Undergraduate Institution

This prize honors a physicist whose research in an undergraduate setting has achieved wide recognition and contributed significantly to physics and who has contributed substantially to the professional development of undergraduate physics students.

Daniel A. Pitonyak (Lebanon Valley College), 2026 recipient. For excellent contributions to our understanding of the spin and multi-dimensional structure of hadrons, and for outstanding mentoring of undergraduate students by engaging them in high-impact research projects.

APS Fellows Recognized Through FEd

We are proud to congratulate Arlene P. Maclin, elected in 2025 as a Fellow of APS through the Forum on Education.

Arlene P. Maclin (MacSmith STEM Enterprises), 2025, recipient. For outstanding professional support to students and young faculty to engage in the science and engineering enterprises through internships, fellowships and other awards.

Call for Nominations

APS Fellowship through the Forum on Education.

We are asking our FEd membership to consider nominating colleagues for APS Fellowship. This distinctive honor signifies recognition by one's professional peers. Through its Fellowships, FEd honors forum members who have made broad, significant contributions to physics education, not limited to research in physics education. More information can be found at https://www.aps.org/funding-recognition/aps-fellowship/fed-fellowship

Please remember

- Nominees must be APS members.
- A nomination requires recommendation letters from a sponsor and co-sponsor and up to two additional letters of support.
- Previous nominations do not automatically enter the 2026 nomination pool. Nominators are required to recertify the nomination in its original form or with updates by the deadline, **June 01, 2026**.

Improving Undergraduate Physics Education Award.

We are asking our FEd membership to consider nominating your department, and/or undergraduate-serving programs, organizations, alliances, and networks in physics that strive to improve student access and success in physics. The information for this award has been updated on the APS website to more effectively communicate eligibility criteria and the review and selection process. This information, along with details on the past recipients, can be found here: https://www.aps.org/funding-recognition/award/improving-undergraduate-physics-education

The deadline is August 7th.

From the Editor

***Alessandro Cunsolo**, Fed Newsletter Editor in Chief, University of Wisconsin-Madison*

In this issue of the FEd Newsletter, our Past-Chair Geraldine L. Cochran invites us to celebrate our 2026 award recipient and to submit nominations for the 2026 Fellowship by June 1 and for the Undergraduate Awards by August 7. Our leadership, represented by the Past Chair and the Chair-elect, Tino Nyawelo, is working to support V.I.T.A.L. faculty, which includes Visiting, Instructors, Temporary, Adjunct, and Lecturers, by removing barriers to their professional growth and helping them feel included in our community. The Chair of the APS Committee on Education, Mila Kryjevskaia, outlines the links between the FEd and the Committee on Education (COE) and invites FEd community members to share their feedback in a community survey on the Committee's main focus areas. These include the EP3 Guide, curriculum reform for the quantum workforce, and emerging topics such as AI ethics and mental health.

One of this month's article contributions -from Clasuell Mathis- questions the "intellectual hierarchy" in physics. This mindset is common among many physics instructors, who view intellectual struggle not as a foundational part of the learning process but as a sign of not belonging to the Physics community and of not deserving inclusion. Clasuell calls for more empathetic, inclusive, and culturally responsive teaching.

After almost 12 years, Alma Robinson offers her final contribution to this Newsletter as Editor of the Teacher Preparation. We gratefully acknowledge her invaluable service to this Newsletter and will greatly miss her perspective in this crucial role. In this issue, Spencer Perry explores the history and application of the Pedagogical Content Knowledge (PCK) framework in physics education. Justin Fournier and Prashanth Jaikumar discuss the successful PhysTEC program at California State University Long Beach (CSULB), which recognizes postsecondary institutions that graduate five or more physics teachers in a given year. They also invite us to join the 25th-anniversary PhysTEC Workshop in Washington, D.C., this August.

We Are Here to Support You: Share Your Priorities in the COE Community Survey

Letter from the Chair of the APS Committee on Education

***Mila Kryjevskaia,** Department of Physics, North Dakota State University*

Dear colleagues,

Thank you for being part of the Forum on Education and helping build a community that considers education vital to the field of physics.

We are aware that many FEd members may not know that the FEd executive committee works closely with the APS Committee on Education (COE), so we would like to share more about that connection and the role COE plays within APS.

APS Committee on Education is a standing Council committee that works closely with FEd to bring community perspectives into APS discussions and decisions on physics education. Our role is advisory, and our effectiveness depends on understanding what FEd members need most. We rely on your experiences, concerns, and ideas to help us represent the community well, which is why your feedback and thoughts are important to us.

Over the past year, the Committee on Education has been engaged in a range of conversations and initiatives that shape how APS approaches physics education. We would like to share more about our current focus areas and the topics we believe may warrant deeper attention in the near future. **Our aim is not only to inform you, but to invite your perspective.**

At the end of this letter, we included a link to a short survey. **We warmly invite you to share your feedback on the importance of our focus areas to you and to suggest topics that you believe deserve attention.**

Focus Area 1. Increasing awareness and advocacy for EP3 guide

One of COE's most significant responsibilities is the oversight of the Effective Practices for Physics Programs (EP3) Guide, a joint effort of APS and AAPT. The EP3 Guide addresses a wide range of topics central to sustaining and strengthening thriving physics programs. It provides concrete practices along with implementation strategies. It reflects the combined efforts over the past ten years of hundreds of physics educators.

Despite the tremendous effort that went into creating the Guide, many departments have not yet recognized its potential. We are working to increase EP3's visibility among physicists, integrate EP3 into conference programming, and identify more effective ways to connect departments with the resources it provides.

Focus Area 2. Curriculum Reform and Quantum Workforce Preparation

The COE Curriculum subcommittee has focused on ways to enhance the relevance of undergraduate physics programs in light of changing student interests and workforce needs. We are exploring how the physics major could evolve to remain compelling to students drawn to quantum information science, computing, and technology development.

Focus Area 3. Non-Tenure Track and VITAL faculty support

The committee recognizes that in many departments, a substantial portion of teaching and mentoring is done by faculty in VITAL roles: Visiting faculty, Instructors, Teaching faculty, Adjuncts, and Lecturers. These colleagues play an important role, yet they often do not feel fully integrated into their home departments and the broader APS community. Many are not active APS members.

COE has formed a working group to better understand how APS can serve this community more effectively. Conversations have focused on professional development opportunities, recognition, representation in APS activities, and structural changes to make participation more accessible. We believe that strengthening connections with VITAL faculty is not only about inclusion and recognition but also key to supporting high-quality physics education.

Focus Area 4. Policy, Advocacy, and Federal Funding

A COE subcommittee on educational policy is working closely with the APS Physics Policy Committee (PPC) to monitor the development of federal policies affecting the reduction of high-impact science funding, visas, and other relevant programs. In line with our advisory role, we have shared concerns and implications for physics education.

Topics that may warrant deeper attention in the future.

Topic 1. The role of APS in Supporting K-12 Education

Physics teachers introduce students to the subject, shape their early identities, and often determine whether students pursue careers in STEM. The health of our field depends directly on the expertise and commitment of physics teachers. We began discussions about how APS can integrate physics teachers into the Society on a broader scale.

Topic 2. AI and Ethics in Physics Education

The committee began discussions on large language models in physics education, recognizing both concerns about ethics and academic integrity and opportunities for learning and educational innovations.

Topic 3. Student and Faculty Mental Health

The committee started discussions about mental health, neurodivergence, advisor-advisee relationships, and departmental culture. Although still in the early stages, these discussions emphasize the need for evidence-based practices, potential inclusion of such practices in a new section of the EP3 guide, and collaboration with the Forum on Education programming.

Now, we invite you to provide feedback on the COE Focus Areas and other topics of interest. Please follow the link.

Note: This survey also contains questions related to the essential contributions and the ongoing challenges faced by VITAL faculty, as discussed in detail in the letter by Geraldine L. Cochran and Tino Nyawelo

https://ndstate.co1.qualtrics.com/jfe/form/SV_026z74mDBDN1KZM

Mila Kryjevskaia on behalf of the Committee on Education

What Is the Issue with Physics Education?

***Clausell Mathis II**, Michigan State University*

One persistent issue in physics education is the culture of perceived intellectual superiority that exists within parts of the field. “Smart” is, of course, a subjective label. Yet when we look more closely at those who are often positioned as exceptionally “smart” in physics, we find that they are just as human and just as flawed as the people they sometimes judge. While I won’t offer specific examples here, this culture of intellectual hierarchy contributes to the exclusion many learners feel when encountering physics for the first time.

Physics has long been framed as a discipline where struggle is interpreted not as part of learning, but as evidence that one simply does not belong. For some students, this narrative fuels persistence. For many others, it leads to disengagement and the belief that physics simply “isn’t for them.” This mindset—often reinforced implicitly through classroom interactions and disciplinary norms—deserves critical examination. At the very least, students should be made aware that such attitudes exist in the field so they can recognize and navigate them rather than internalize them as personal failure.

There have been many initiatives aimed at broadening participation in physics. However, too often these efforts fail to meaningfully center the learner’s perspective. Educators and physicists may underestimate how their tone, assumptions, and ways of responding to questions or mistakes can shape whether students feel welcomed or alienated. Many of us bristle when our own work is dismissed or misunderstood—yet we too often extend far less grace to students who are struggling to understand physics for the first time.

I encourage physics educators to more intentionally practice empathy toward learners who are working to make sense of physics ideas. Attending to students’ struggles, uncertainties, and partial understandings is not a lowering of standards—it is a commitment to teaching in ways that expand, rather than shrink, the community of people who see themselves as capable of doing physics. If we want to grow physics, we must stop confusing intellectual gatekeeping with rigor—and start building classrooms where struggle is treated as evidence of learning, not of inadequacy.

Building Culturally Responsive Physics Through University–Teacher Partnerships: Lessons from a Michigan State Initiative

***Clausell Mathis II**, Michigan State University*

Across the United States, physics teachers are increasingly being asked to make their instruction more relevant, inclusive, and connected to students' lived experiences. At the same time, many teachers report that they lack concrete models for how to do this in ways that preserve disciplinary rigor and align with standards. University faculty, too, often want to support local teachers but are unsure how to build sustained, productive partnerships that go beyond one-off workshops or guest lectures.

At Michigan State University, we are piloting an initiative designed to address these challenges by bringing physics teachers and university faculty together in a professional learning community (PLC) focused on culturally grounded, NGSS-aligned physics and chemistry curriculum design. The goal is not simply to "add context" to existing lessons, but to support teachers in leveraging students' cultural resources—such as community knowledge, local phenomena, interests, and everyday problem-solving practices—as legitimate entry points for engaging in the practices of physics.

Structure of the Initiative

The initiative centers on a year-long PLC that brings together secondary physics and chemistry teachers from multiple districts with university faculty and graduate students. PLC meetings occur regularly throughout the school year and are organized around three core activities:

1. **Surfacing cultural resources and local phenomena.** Teachers collectively identify cultural resources that are meaningful in their students' communities—such as transportation, sports, energy use, weather, or local industries—and discuss how these resources can anchor physics sensemaking.

2. **Co-designing curriculum and assessments.** Teachers work in small groups to design instructional sequences that integrate these cultural resources with core physics ideas and practices (e.g., energy, forces, modeling, data analysis). Faculty support alignment with NGSS performance expectations while teachers ensure the designs remain feasible within real classroom constraints.

3. **Iterative refinement and enactment.** Teachers pilot lessons in their classrooms, bring student work and reflections back to the PLC, and collaboratively refine the materials. This design–enact–reflect cycle helps keep the work grounded in practice rather than abstract ideals.

Rather than positioning the university as the sole source of "expertise," the PLC is organized around the principle that teachers are experts in their own classrooms and communities. Faculty play a supporting role—helping with disciplinary coherence, assessment design, and access to resources—while teachers lead decisions about what is culturally meaningful and pedagogically workable.

What's Different About This Approach

A key feature of the initiative is its focus on disciplinary learning alongside cultural relevance. In many conversations about culturally responsive instruction, teachers express concern that relevance may come at the expense of rigor. The PLC intentionally centers this tension as a design problem: How can lessons be grounded in students' experiences while still supporting deep engagement with physics ideas and practices?

Teachers in the PLC work to make explicit connections between local phenomena and disciplinary representations (graphs, equations, models), and to design tasks that require students to construct explanations, analyze data, and engage in scientific argumentation. For example, lessons anchored in local transportation or energy use are paired with modeling activities that foreground force diagrams, system boundaries, or conservation principles. In this way, cultural relevance becomes a vehicle for doing physics, not a substitute for it.

Early Insights and Promising Outcomes

Although the initiative is ongoing, several promising patterns have emerged:

- **Teachers report increased confidence** in designing lessons that feel both authentic to their students' lives and aligned with disciplinary goals.

- **PLC conversations have shifted** from "How do I make this more relevant?" to "What physics ideas do I want students to figure out, and how can their experiences help them get there?"

- **Curriculum products** developed through the PLC reflect more coherent integration of phenomena, practices, and core ideas, with clearer attention to assessment of student sensemaking.

Importantly, teachers emphasize that the sustained nature of the PLC—meeting over months rather than days—has been critical. Trust, shared language, and concrete design expertise take time to develop, and short workshops rarely provide enough space for this kind of growth.

Why This Matters for the FEd Community

For members of the APS Forum on Education, this work highlights one possible model for how physics departments can engage meaningfully with K–12 partners. Rather than offering isolated outreach activities, departments can support long-term, reciprocal partnerships that contribute to teacher learning, curriculum quality, and ultimately students' opportunities to engage deeply with physics.

The PLC model is adaptable to different institutional contexts. Departments with limited resources can begin with small cohorts of local teachers, focus on one content area, or partner with existing networks (e.g., PhysTEC sites, regional teacher alliances). What matters most is creating sustained space for teachers and faculty to design, reflect, and learn together.

Looking Ahead

We are continuing to refine the PLC structure and to document how teachers' curriculum design practices evolve over time. In the future, we hope to share open-access curricular materials and facilitation guides that other departments can adapt for their own contexts. If you are interested in exploring similar partnerships or learning more about this work, I welcome conversation and collaboration.

The Obvious Cheater

By Matthew Wright

I work hard to be a flexible instructor. I don't want any unfortunate life event outside of the student's control to affect their GPA. I want to help encourage them to overcome the things that life throws at them and not get overwhelmed and give up. This definitely helps some students. But the unfortunate reality is that some students see this and start trying to find ways to take advantage of you. These students start circling you like sharks.

I was recently chatting with one student. He had been in my class and had absolutely no clue what was going on in the class. Every text book homework problem I assigned him was handed in, perfectly done, with the final answer boxed, and to within three significant digits of the correct answer. If I made up my own problem, no matter how easy, he didn't even try it.

We were in a sophomore mechanics class and I asked him to go to the white board (with teammates) and solve a problem. I made sure he had the marker. He couldn't figure out how to get started. I said start with Newton's 2nd law. He looked at me as if I was from another planet. Finally, one of his friends kicked him and said write down F=ma.

I was confused! I had checked up on my students at the beginning of the semester. The student's intro to physics and calculus grades were all A+. How is that even possible? He had gotten a very high grade on the first test in this class. Maybe he is just a really good at taking tests or nervous speaking in front of people. Maybe he is having a bad day? But then you started hearing other students complaining about how students were using their phones on the test. And how can he have a bad day everyday?

So, for their second test, I made them put their phones in the front of the room during the test. That will show them. But as the test was being taken, I could see my student looking into his lap where he had a sweatshirt resting. Underneath the table, I could just barely perceive that this arm was moving a little bit, although I could not see his fingers working the phone wrapped in his sweatshirt. Though as soon as I looked his way, his eyes quickly darted back to the paper.

I just stopped what I was doing and looked directly in the direction of the student. His eyes darted up from the page toward me and back to the page and back to me. This uncomfortable dance continued for far longer than it should have. This turd brought a second phone and is so good at cheating I can't even see how he is doing it. I got up and casually walked over to his corner of the room and sat down near him. It was now impossible for him to cheat on the exam. Though I worry that this 6 foot 300 pound obnoxiously loud physics professor sitting next to the student during the exam might be a form of intimidation. I don't care. I think he was cheating.

Grading the exams went as expected. As a physics professor, like almost every other physics professor, getting a 50% on an exam is a great score. The first problem this student tried was done to perfection. The rest of the exam was completely blank. Fairly graded, not taking into account the cheating, the student got a 20% and a D- on the exam. I guess I caught them cheating, but I don't think I have enough evidence to take this to the dean's office. I guess they get a D-.

At the start of the next class, I stood in front of the students and said, You are paying $200,000 for me to turn you into a physicist. If all you can give me is what ChatGPT says, then why would I ever spend a dollar to hire you, I would just use ChatGPT. The exam studying process is how you learn how to be a problem solver, how to prepare, and how to be better than AI. When you cheat you deny yourself the most important lesson. If you want to waste your money, there are better things to spend it on.

Oh god, I am droning on, if I don't stop, I will be whining about how I had to walk up hill both ways to school in the snow. And even worse, I can tell that the only people that are listening to me are the ones who aren't cheating. The ones that need to hear it are sleeping in the back or didn't show up to class.

Okay, this story was fiction. It was built from conversations and experiences I have had over the last two or three years. I have become surprised at how successful the students are at cheating and how much vigilance is needed to stop it. I wrote this because I wanted you to share my frustration in how difficult the issue is.

Matthew J Wright, Ph.D.
Pronouns: he/him/his
Professor
Physics Department Chair
Director of the Business of Science
Adelphi University, Physics Department
Web: https://cosmicpathways.org/
Email: mwright@adelphi.edu
Phone:516-877-4843

PhysTEC Section on Teacher Preparation

***Alma Robinson**, Virginia Tech*

After almost 12 years, this issue will be my final one as editor of the Teacher Preparation Section. It's been a pleasure to learn from this community and to help disseminate the incredible work that physics teacher preparation programs are undertaking across the country.

In this issue, Spencer Perry offers a brief history of the Pedagogical Content Knowledge (PCK) framework and invites physics teacher educators to reflect on how PCK can support their teachers' development. Physics teacher educators can use a PCK framework to design curriculum that explicitly encourages teachers to connect their content knowledge, teaching practices, and beliefs about teaching.

Justin Fournier and Prashanth Jaikumar discuss the successful PhysTEC program at California State University Long Beach (CSULB). PhysTEC created the 5+ Club to recognize postsecondary institutions that graduate five or more physics teachers in a given year, a number that places them in the 99th percentile of all institutions for physics teacher graduates. CSULB has been named a 5+ Club awardee for many years, and their article highlights what makes their program thrive.

The 2026 PhysTEC Workshop (https://phystec.org/events/2026-workshop/) will be held August 7-9 in Washington, DC, and will celebrate 25 years of PhysTEC! This is an excellent opportunity to connect with dedicated physics teacher educators.

Rethinking Pedagogical Content Knowledge in Physics Teacher Preparation

***Spencer Perry**, Indiana University Bloomington*

Intro

Those who cannot do, teach. This rather disparaging and profoundly untrue phrase has been repeated (sometimes in jest) since well before anyone reading this was born. Offering a rebuttal was one of Shulman's (1986; 1987) motivations for articulating the idea of pedagogical content knowledge (PCK). Shulman argued that productive instruction requires all the knowledge of the practitioner (i.e., a physicist) as well as the pedagogical knowledge of a teacher. He called the intersection of these two knowledge bases PCK.

You might ask why anyone should worry about describing this type of knowledge. As an educational researcher, conceptual frameworks like PCK can be valuable to create structured research arguments. As a teacher educator, I see value (and limitations) in PCK frameworks for teacher preparation. Many researchers have written about PCK, with Shulman's foundational articles having over 83,000 Google Scholar citations. Whether you love it or hate it, PCK is an important idea to understand in science education research.

What is PCK

Different researchers have tried to define and categorize teacher knowledge, often through a lens of PCK. Usually this means defining categories of teacher knowledge and establishing models of interaction among those categories. Some influential models include Magnusson et al. (1999), Park and Oliver (2008), the "Consensus Model" (Gess-Newsome, 2015), and the "Refined Consensus Model" (Carlson et al., 2019). Each model has its affordances and limitations to physics education research, and the list I offer is anything but exhaustive.

PCK Components

Next, I'll discuss one of these models, Park and Oliver (2008). I selected this model because it's relatively simple, yet still functional. Park and Oliver argued that teacher PCK is composed of knowledge bases that can be categorized as: (1) Orientations toward teaching science, and knowledge of (2) Instructional Strategies, (3) Assessment, (4) Curriculum, and (5) Students' Understanding. Park and Oliver offer a model where these all influence each other, and they develop and change together over a teacher's career.

Every physics teacher has a certain set of orientations or beliefs toward teaching, and they are not always aware of those beliefs. These are influenced by our own experiences as physics students (Lortie, 1975), our beliefs about the nature of science, the purpose of our physics classes, and even our own identities. You might know a physics teacher who describes themselves as a *modeler*, in reference to a specific approach to teaching physics. Other teachers may focus on academic rigor, wanting their students to be able to solve complex and difficult physics problems.

Knowledge of instructional strategies refers to the strategies a teacher knows for specific topics. Many books are filled with strategies for teaching physics. They might include labs for specific topics, whiteboarding strategies, lesson ideas, or demonstrations. These are often the sorts of things I see teachers asking for in professional development. I sometimes call them "Monday-ready" activities.

Knowledge of assessment refers to a knowledge of assessments themselves, assessment strategies, and assessment theory. Perhaps you know of some specific assessments in physics like the Force Concept Inventory or the Energy Concept Assessment. Perhaps just as important as knowing about these assessments is a functional knowledge of assessment theory to help develop and critique your own assessments.

Knowledge of physics curriculum means a knowledge of learning standards like the Next Generation Science Standards, various state-specific learning standards, and what students should expect from assessments like the physics GRE. It also includes a knowledge of specific programs like AP Physics and approaches like Modeling Physics.

Knowledge of students' understanding of physics includes a knowledge of what students need to understand to approach a physics topic, what motivates students to learn, the types of difficulties students face, and student misconceptions. For example, I typically teach vectors before teaching projectile motion. I also know that my students don't always come to me with the trigonometry skills I wish they had, so I may need to review that topic as well.

Other models of PCK might include different components that interact in different ways. There are also models that attempt to describe content-specific PCK such as Computer Science PCK (Yadav & Berges, 2019). To my knowledge, no model of PCK specific to teaching physics has been adopted on a wide scale, though I have entertained the question of whether there should be.

How do researchers and teacher educators use PCK?

As a conceptual framework, PCK offers affordances for addressing at least two important questions about physics teacher knowledge. The first question, which is asked in some form by most physics education researchers who adopt PCK frameworks, is whether teachers <u>have sufficient</u> knowledge for success. Examining this question quickly makes it clear that operational definitions are needed for "sufficient," "knowledge," and "success." These are not easy to define, but they do lend themselves well to the sort of cognitive approaches that many in PER gravitate toward.

Another group of questions for which PCK may serve as a suitable framework for analysis is questions about whether teachers have <u>access</u> to different forms of PCK. How does a program's teacher preparation approach individual PCK components and how do those approaches interact with beliefs and practices? This kind of questioning is inherently more sociocultural in nature.

Limitations

The use of PCK as a framework for research and practices comes with some important limitations. One is that the theories that undergird much of existing PCK research positions learning through transmission of knowledge (Settlage, 2013). Under scrutiny, these views are probably opposed to the various flavors of constructivism learning with which physics education researchers often claim to align.

Another major limitation of using PCK is that it may implicitly steer researchers toward framing their work through a deficit lens (Gray et al., 2022) by positioning teachers' knowledge as something that is lacking or needs to be gained. Furthermore, I have often wrestled with how I can possibly evaluate teachers' PCK without using my own experiences (e.g., white, male, cis) as a benchmark, thus establishing an evaluative system where my own perspectives represent the ideal—something for which I have no appetite.

It is because of these limitations that I tend to think about Pedagogical Content Knowledge as a framework for thinking about giving teachers access to knowledge so they can construct their own understanding and beliefs about teaching. If I really believe that specific types of knowledge are important for teaching, then I should facilitate teacher preparation that makes them available to preservice teachers. Despite its flaws, I see PCK as a framework to support teacher preparation in this way. My hope is that readers who plan and lead physics teacher preparation programs will consider the types of knowledge that they want their teachers to leverage in their physics classrooms so that those programs can facilitate teachers' pedagogical development for effective and joyous physics teaching.

Spencer Perry is a recent Ph.D. graduate from Indiana University Bloomington where he studied Curriculum and Instruction with a concentration in Science Education. His research focuses on physics teacher career retention patterns and the reasons they persist in the teaching profession.

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The Legacy and Accomplishments of the PhysTEC Program at CSU Long Beach

Justin Fournier

Dr. Prashanth Jaikumar

The PhysTEC program aims to be a sustained and impactful response to one of the most persistent challenges in science education: the shortage of well-prepared physics teachers in the United States. At California State University Long Beach (CSULB), through a combination of early recruitment, immersive coursework, and strong community engagement, the program has developed into a nationally recognized model for physics teacher preparation. Its continued recognition as a member of the PhysTEC "5+ Club" since 2021/22, awarded to institutions that graduate five or more qualified physics teachers in a single year [1], reflects both its effectiveness and its durability.

The CSULB PhysTEC program, initiated in 2010 by Profs. Laura Henriques, Chuhee Kwon, and Galen Pickett [2], and currently shepherded by the authors, is built on a collaborative foundation between the Department of Physics and Astronomy, the Department of Science Education, and local K-12 educators. This partnership has been supported by national organizations such as the American Physical Society (APS) and the National Science Foundation (NSF), ensuring that future physics teachers at CSULB receive both content training and a deeper understanding of pedagogy.

Central to the program's success is its intentional teacher preparation pipeline, which engages students at multiple stages of their academic journey. Early recruitment plays a critical role: our faculty actively promote teaching as a respected and attainable career path for physics majors in multiple courses and circulate resources from *Get The Facts Out* [3], helping to shift departmental culture and normalize teaching as a professional goal.

This recruitment effort is paired with structured, *experiential* coursework. PHYS 390: Exploring Physics Teaching serves as an entry point for undergraduates considering a teaching career. In this course, students examine physics education research, reflect on effective teaching practices, and gain firsthand exposure to the classroom under the guidance of experienced high school teachers brought into the university environment using the *Teacher-in-Residence* model. Fieldwork is a defining component - students in PHYS 390 observe local high school physics classes and serve as Learning Assistants in introductory university labs. These experiences allow them to test their interest in teaching while developing foundational instructional skills.

Physics high school teachers and CSULB students gather at Demo Day once a month to share ideas around crafting and presenting engaging classroom demonstrations.

For students who continue along the teaching pathway, PHYS 491: Pedagogical Content Knowledge in Physics provides a more advanced and integrative experience. This series of courses brings together undergraduates, pre-service teachers, and experienced educators in a collaborative learning environment. Organized around core physics topics such as energy, momentum, electricity, and magnetism, the course series emphasizes the practical aspects of teaching: designing labs, demonstrating concepts, and addressing common student misconceptions.

A defining feature of PHYS 491 is its dual-perspective approach. Students are required to alternate between the roles of learner and teacher - engaging in activities as students while simultaneously analyzing them through a pedagogical lens. This

"Make & Take" workshops equip teachers with materials to build and employ in their own classrooms.

"student hat/teacher hat" framework encourages metacognition and helps participants develop a nuanced understanding of how students learn physics. Assignments, including interviews with K-12 and adult learners on physics concepts, further connect the theoretical coursework to the realities of the classroom.

Beyond formal instruction, community building is a cornerstone of the CSULB PhysTEC program. Monthly "Demo Days" [4] serve as vibrant hubs of professional interaction, bringing together K-12 teachers, university faculty, and pre-service educators, intentionally designed to foster collaboration, creativity, and the exchange of practical teaching strategies. Demo Days typically take three forms. In themed demonstration sessions, participants share and refine physics demonstrations tied to specific content areas. Engineering challenges introduce an element of friendly competition, engaging educators in hands-on design tasks aligned with the Next Generation Science Standards (NGSS) Science and Engineering Practices. "Make & Take" workshops allow participants to build classroom-ready materials, ensuring that ideas generated during the sessions can be ultimately implemented in their own teaching.

Recent activities highlight the creativity and energy of these events: participants have designed turbine blades to optimize power generation, built sailboats for canal races, and engineered water balloon bungee systems launched from stairs in the Hall of Science building. These experiences not only deepen content understanding but also model engaging, inquiry-based approaches to teaching physics. Importantly, participation in Demo Days is integrated into the PHYS 390 and PHYS 491 courses. This ensures that students are not learning in isolation but are instead becoming part of a broader community of practice. They gain exposure to experienced educators, build professional networks, and develop a sense of identity as members of the teaching profession.

The impact of the CSULB PhysTEC program extends beyond individual students. Our PhysTEC faculty champions have played a leading role in establishing the Southern California PhysTEC Regional Network [4], which connects multiple campuses in a coordinated effort to increase the number of qualified physics teachers. This network facilitates the sharing of resources, strategies, and program innovations, amplifying the program's reach and contributing to a more systemic approach to addressing regional workforce needs. The program's influence is also evident in the achievements of its alumni. Graduates have gone on to receive honors such as local PhysTEC Teacher of the Year [5], underscoring the effectiveness of their preparation and their contributions to high school physics education. These successes provide visible examples of the impact teachers in the PhysTEC network have had on their students and in their schools.

Leadership has been another critical factor in the program's development and recognition. Faculty members Profs. Laura Henriques, Chuhee Kwon, and Galen Pickett have contributed not only to campus initiatives but also to national conversations about STEM education. Their involvement in advisory boards, regional networks, and professional organizations has helped position CSULB as a model for other institutions seeking to strengthen physics teacher preparation.

Although early PhysTEC grants concluded in the 2010s, the structures established—courses, partnerships, and community events—have been institutionalized within CSULB. This sustainability reflects strong alignment with institutional priorities and a shared commitment across departments to supporting future educators. In sum, the PhysTEC program at CSU Long Beach exemplifies how a comprehensive, collaborative, and community-centered approach can transform physics teacher education. By integrating early recruitment, experiential learning, and sustained professional engagement, the program not only increases the number of qualified physics teachers but also enhances their preparation and long-term success. Its continued recognition in the PhysTEC 5+ Club and the accomplishments of its graduates all point to a model that is both effective and enduring. As the demand for skilled STEM educators continues to grow, the CSULB PhysTEC program offers a compelling blueprint for meeting this critical need.

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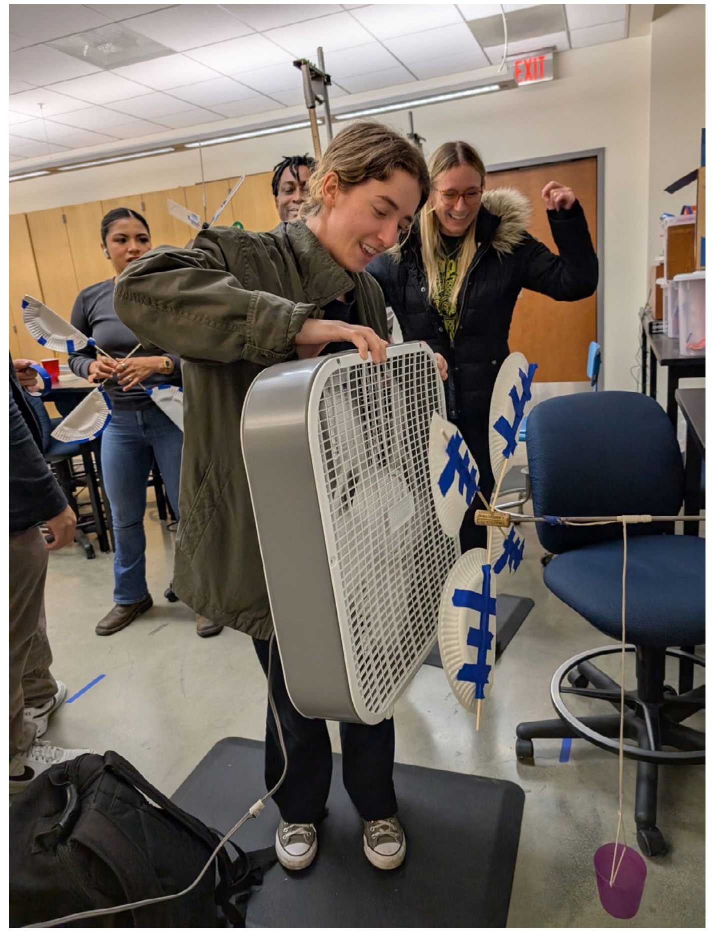
Justin Fournier is part-time faculty at California State University Long Beach, and a teacher at Cypress High School in the Anaheim Unified High School District. Dr. Prashanth Jaikumar is faculty and currently the Chair of the department of Physics and Astronomy at California State University Long Beach.



Groups of teachers and students tackle engineering challenges with creative and fun designs, rounding out our Demo Days each semester.

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[1] CSULB Physics features in the PhysTEC "5+ Club" article – https://phystec.org/awards/five-plus-club-awardees/

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[5] CSULB PhysTEC Teacher of the Year article - https://phystec.org/awards/teacher-of-the-year/all/

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