APS Forum on Education
FEd

Spring 2025 Newsletter
Alessandro Cunsolo, Editor

Letter from the Chair

Geraldine L. Cochran, *The Ohio State University*

Dear Members of the APS Forum on Education,

I write to you as Chair of FEd during a time of significant challenge for many in our community. Like many of you, I am grappling with the abrupt termination of research grants, the distress experienced by students and colleagues who have lost their positions, and what feels like a broader attack on science, education, and science education. These are not just policy issues—they are deeply personal impacts on the lives and work of those committed to advancing physics and learning.

In these moments, I am reminded of the vital role that communities like FEd play in supporting, amplifying, and sustaining one another. As Past Chair Dan Claes often says, "FEd is for physicists who care about education, and every physicist should care about education." I wholeheartedly agree. Education is not peripheral to our work—it is foundational. And supporting one another during this time is a powerful act of resistance and resilience.

As I've grown into my role as Chair, I've gained a deeper appreciation for how FEd connects to other APS units and decision-making bodies. I'd like to take a moment to highlight FEd's collaboration with three specific APS Units.

Committee on Education (COE). Three members of the FEd Chairline serve on COE (Past Chair, Chair, and Chair-Elect). This ensures that the perspectives and needs of the education-focused APS community are communicated and considered in broader APS initiatives. It is the responsibility of FEd to share the interests and priorities of our membership with COE. Some members have already reached out regarding this and I thank you. I encourage more members to continue to communicate their interests and needs to FEd leadership. I am also working with the incoming COE chair to develop a survey to more easily facilitate FEd members communicating with FEd and COE.

FEd maintains strong ties with other APS units to align efforts and support shared goals. For example, FEd appoints a representative to the Executive Committee of the Topical Group on Physics Education Research (GPER) to foster ongoing coordination—this year, that representative is Brianne Gutmann. FEd also appoints a representative to the Executive Committee of the Forum on Outreach and Engaging the Public (FOEP); this year, that representative is Diana Sachmpazidi.

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.

These collaborations help ensure that our work reflects the broader needs of the physics education community and is informed by interdisciplinary perspectives.

To better facilitate communication, I include below the members of the FEd Executive Committee and our roles. I find that it is much easier to communicate with an appropriate individual rather than to email an entire listserve.

FEd Executive Committee

Geraldine L. Cochran (The Ohio State University) - Chair

I am leading the Membership Committee this year. My goal is to improve communication between FEd members and FEd leadership.

Daniel Claes (University of Nebraska–Lincoln) – Past Chair Dan is leading the Honors and Awards Committee this year. You can read more below about the awards FEd oversees, as well as those we coordinate in partnership with COE.

Clausell Mathis (Michigan State University) – Chair-Elect Clausell is chairing the Program Committee and leading preparations for FEd-sponsored sessions at the 2026 APS Global Physics Summit. Your ideas and input are welcomed and encouraged. Details about FEd's participation in the 2025 Summit are shared later in this letter.

Tino Nyawelo (University of Utah) – Vice Chair Tino is heading the Nominating Committee this year. The continued success of FEd depends on dedicated volunteers—please consider nominating a colleague or running for an Executive Committee position yourself.

Ashley Carter (Amherst College) – Secretary/Treasurer This will be Ashley's final year in the role. She has been instrumental in keeping our operations organized, consistent, and efficient. We are deeply grateful for her service.

Gay Stewart (West Virginia University) – Councilor Gay represents FEd on the APS Council, which oversees matters related to science and membership, including science policy. She also ensures coordination with the Topical Group on Physics Education Research (GPER) and the Forum on Outreach and Engaging the Public (FOEP), helping elevate our shared priorities to the APS Board.

Alessandro Cunsolo (Brookhaven National Laboratory) – Newsletter Editor We're pleased to welcome Alessandro as our new editor for the next three years. Thank you for your patience as we prepared this newsletter—I'm especially grateful for your support as I finalized my own contribution.

Katarzyna Pomian Bogdanov (Northwestern University) – Graduate Student Member We are excited to have Katarzyna join us this year as our graduate student representative.

Members-at-Large: Carlton Pennypacker Diana Sachmpazidi (Rochester Institute of Technology) Vasudevan Lakshminarayanan (University of Waterloo) Brad R. Conrad (National Institute of Standards and Technology) Brianne Gutmann (San Jose State University) Amy Furniss (Santa Cruz Institute for Particle Physics)

It may seem like a large team—and it is! That's because FEd does a lot of work to serve our members, and I hope the contents of this newsletter reflect that. I am truly grateful to each person listed above for their service and leadership.

Celebrating Outstanding Contributions: 2025 FEd and COE Awards

Each year, the APS Forum on Education and the APS Committee on Education recognize individuals and departments making exceptional contributions to physics education. We are proud to highlight the following 2025 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.

Stephen Padalino (State University of New York - Geneseo), 2025 recipient. For creating an inclusive undergraduate physics education program in the classroom and laboratory settings that captures the imaginations of undergraduate students to perform fundamental research in preparation for a life of research.

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.

Trinity University – Department of Physics and Astronomy For building an inclusive learning environment, launching an Applied Physics degree, and enabling over 75% of students to engage in research.

University of California, Riverside – Department of Physics and Astronomy For integrating student-centered pedagogy in small classes, providing early research exposure, and connecting classroom learning with professional development.

University of Massachusetts Amherst – Department of Physics For a curriculum that weaves professional development throughout four years, strong growth in majors, and deep support for peer mentoring, cohort-building, and research engagement.

University of San Diego – Department of Physics and Biophysics For offering flexible pathways in physics and biophysics, requiring research or experiential learning, and promoting early student engagement with high-impact faculty mentorship.

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.

Jason D. Slinker (The University of Texas - Dallas), 2025 recipient. For continuous physical measurement laboratory improvements, leveraging industrial and academic partnerships that enable innovative and diversified independent student projects, and giving rise to practical skillsets yielding outstanding student outcomes.

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.

Will Raven (Smith College) For high precision laser spectroscopy of complex atoms and the percent level verification of quantum electrodynamics in Beryllium-9, and for innovative and extensive involvement of undergraduate students at Smith College in this research.

APS Fellows Recognized Through FEd

We are proud to congratulate **Enrique Jose Galvez** and **Katemari Rosa**, both elected as 2025 APS Fellows through the Forum on Education:

- Enrique Jose Galvez (Colgate University) For mentoring undergraduate students in research and coursework, developing transformative approaches to single-photon quantum optics labs, and expanding access to training in quantum sciences.
- Katemari Rosa For dedication to improving physics education globally through research, curriculum development, and fostering international collaborations, and for work on decolonizing physics education to better serve marginalized people.

We thank all nominators and selection committee members. These recognitions highlight the diversity, innovation, and impact of work being done across our community.

Call for Nominations: We encourage all members to consider nominating individuals or departments for next year's awards. Your nominations help ensure that impactful work in physics education is recognized and celebrated. Most award nomination deadlines fall in early summer, so now is a great time to begin thinking about who in your network is making a difference. Together, we can elevate and support excellence across our community.

FEd-Sponsored Sessions at the 2025 APS Global Physics Summit

FEd sponsored numerous sessions at the 2025 APS Global Physics Summit. I highlight just a few here:

Graduate Students As Changemakers in Physics Departments and Beyond

Organized by 2024 graduate student representative on FEd, Danielle Maldonado (West Virginia University), this session featured talks on graduate student-driven change through departmental advocacy, mentorship, labor organizing, and outreach. Speakers shared how graduate students have influenced climate, policy, and retention in physics departments across the country through community building, equity work, and leadership.

Highlights from the Special Collections of AJP and TPT on Teaching About Quantum

Organized by FEd Member-at-Large Gary White (The George Washington University), this session explored innovations in quantum education inspired by recent special issues of American Journal of Physics and The Physics Teacher. Talks included:

- Visualization tools that help students understand quantum states, such as improvements to the Bloch sphere, two-qubit state mapping, and many-qubit intuitions.
- A simplified, hands-on approach to quantum mechanics education using the Bloch Cube, allowing high school and early undergraduate students to explore quantum concepts with minimal math.
- A provocative reimagining of quantum education as Holistic, Equity-oriented, and Research-based ("H.E.R."), highlighting equity-focused curriculum design, the role of media hype, and speculative models for inclusive Quantum 2.0 education.

Co-Sponsored Session with the Division of Computational Physics

In collaboration with DCOMP, this session showcased strategies for embedding computation across undergraduate physics programs. Talks included:

- Computation in mechanics and intermediate lab courses, including recent additions involving Python and generative AI tools.
- Discussion on scientific agency in computational education and introduced "Computational Making"—a

framework for integrating computation with experimental design and inquiry.

- One department's efforts to embed computation programmatically, including Python-based seminar courses, redesigned labs, and a dedicated computational physics course built with PICUP resources.

Presentations offered practical insights into how diverse institutions are equipping physics students with computational fluency aligned with modern research and workforce needs.

Co-Sponsored Session with the Topical Group on Physics Education Research

Organized by FEd Chair (Cochran) This mini-symposium focused on validated assessment tools and how they can inform and improve instruction in physics education. Talks explored instrument development and curricular applications across various institutions. This session underscored how assessment research continues to drive innovation in instructional practice

and course transformation. We encourage the development of future mini-symposia that integrate invited and contributed talks to showcase a broad spectrum of voices and ideas.

In closing, I want to express my appreciation for your continued commitment to physics education, especially in these uncertain times. I hope you find inspiration in the selected achievements and conference sessions shared here, and I encourage you to get involved with FEd—whether by organizing sessions, attending sessions, submitting nominations, serving on a committee, or engaging with members of the FEd community. Together, we can continue to foster a strong, inclusive, and resilient physics education community.

From the Past Chair

Daniel Claes, *University of Nebraska-Lincoln*

We have just wrapped up the APS Global Summit 2025 and among the invited talks sponsored by the Forum on Education we were privileged to hear from Reichert Awardees University of Texas Professor Dallas Jason Slinker (describing "Self-Directed Student Projects in Advanced Physics Laboratories") and Lab Manager David Taylor (speaking on "My Favorite Advanced Laboratory Experiments and Why"). Together these made an inspiring story of the development and sustained excellence of an upper division undergraduate advanced physics laboratory.

APS prizes, awards, and fellowships recognize outstanding achievements in research, education, and public service. With few exceptions, they are open to all members of the scientific community in the U.S. and abroad. As a member of the Forum on Education, you have the opportunity to honor colleagues through nomination to

- APS Fellowship
- the Excellence in Physics Education Award (awarded by the Committee on Education)
- the APS Prize for a Faculty Member for Research in an Undergraduate Institution
- the Reichert Award for Excellence in Advanced Laboratory Instruction.

Each of these has a deadline of **June 2, 2025**.

Forum on Education Fellowships

The APS Committee on Honors has approved the Forum on Education to put forward 5 nominees for consideration in election to 2025 APS Fellowship. We are asking our FEd membership to consider nominating colleagues for this distinctive honor that 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 2025 nomination pool. Nominators are required to recertify the nomination in its original form or with updates by the deadline.

Submit your nominations using the APS Fellowship Nomination online system prior to **June 2, 2025**.

Please also consider nominating a colleague for the following award opportunities.

The Excellence in Physics Education Award honors a team or single individual for sustained commitment to excellence in physics education. Find details at https://www.aps.org/funding-recognition/award/physics-education-award.

Nomination deadline: June 2, 2025

APS Prize for a Faculty Member for Research in an Undergraduate Institution 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. Find details at https://www.aps.org/funding-recognition/prize/faculty-member-research.

Nomination deadline: June 2, 2025

The Jonathan F. Reichert and Barbara Wolff-Reichert Award for Excellence in Advanced Laboratory Instruction honors outstanding achievement in teaching, sustaining, and enhancing an advanced undergraduate laboratory course or courses. Find details at https://www.aps.org/funding-recognition/award/excellence-advanced-laboratory-instruction.

Nomination deadline: June 2, 2025

You may view all APS Honors at https://aps.org/programs/honors/index.cfm.

From the Councilor

***Gay Stewart**, West Virginia University*

Greetings from your Councilor!

As your councilor, I serve to provide a conduit of information between APS and the FEd executive committee and membership. I get to brag on all the great things FEd is doing (you see some examples in this newsletter, and the sessions they helped put together for the Global Physics Summit [GPS] were fantastic)!

I also get to share with you the things APS is thinking and doing to try to support its members. They held some town halls at the GPS and afterwards I pestered FEd, GPER and FOEP folks (the FEd councilor also represents GPER and FOEP) and picked their brains on what they had heard and what they thought APS should know and shared that with the full council.

The APS CEO, Jonathan Bagger reported on their efforts. The APS is doubling down on improving inclusion, in alignment with their mission: APS advances physics by fostering a vibrant, inclusive, and global community dedicated to science and society. While some other organizations are reducing efforts, APS has created a new Department of Inclusion and Collaboration. This team will focus on DEI+ activities across APS, and help coordinate efforts across APS departments, units and committees. This Department is collaborating with the APS Department of Programs and Inclusive Practices, now led by Dr. Crystal Bailey (my undergrad advisee, very proud of her), which is working to create a physics culture that champions access, opportunity, and collaboration, focusing on careers, inclusive mentoring, education, and learning.

APS is offering waivers to new and renewing members who are facing financial hardship. They understand that many in our community are suffering funding uncertainty, and want us to be able to stay connected. APS is serving as a voice for the physics community, launching a multifaceted advocacy

Campaign. They are taking action to support federal STEMM workers and partnering with other societies (AAPT, AAS, SPIE, SPS, and the Council on Undergraduate Research) - the coalition has over 250,000 members. Please read the emails from APS or follow them on social media to see how you can get involved. They are leading a national grassroots effort, but targeting key states, helping faculty in those states set up in-state meetings with their congressional staff. The focus is on FY2026 budget... if science isn't funded it is very hard to continue the work to ensure all can find their home within physics.

New Ethics policies have been rolled out since the revised statement in 2024, with the Ethics Standards and Code of Conduct and new Investigation and Resolution Procedures. You can read more about it at Guidelines on Ethics | American Physical Society. Additionally, the APS has a new Ombuds Program for confidential and informal conflict resolution, harassment or discrimination matters at APS and non-APS activities, available to all APS members (https://www.aps.org/initiatives/inclusion/aps-ombuds-program).

We also discussed APS work in Purpose-Led Publishing, a coalition of society publishers who pledge to put purpose above profit. Unlike the large for-profit publishers, Purpose-Led Publishers invest 100% of funds back into science, publish only the content that genuinely adds to scientific knowledge, and put research integrity ahead of profit. The APS journals have long held a position of respect for their quality, but the larger publishers can work harder to entice authors. Please check them out (Purpose-Led Publishing | American Physical Society) and remember that where you publish does matter!

The APS Governance Committee has a lot on its docket. A major item is a task force being commissioned to take a broad look at APS Units, including risks, opportunities, and bylaws. Units such as FEd engage members with their communities, but they divide the membership into 50 distinct identity groups. APS wants to ensure the Units are structured so that APS can best fulfill its mission and that they deliver real value to their members. There are 10 Sections, based on shared geography; nine Forums, based on shared non-scientific interest; and 31 Divisions and Topical Groups, based on shared scientific interest.

APS also engages in creating policy statements and reports. Policy Statements are APS statements articulate our society's enduring positions on topics relevant to the physics community and guide APS activities, including authorizing our federal advocacy efforts (https://www.aps.org/about/governance/statements). APS science policy reports present technical assessments in areas of interest to the physics community, policy decision-makers, and the general public. Topics covered in these reports range from energy and the environment to national security (https://www.aps.org/publications/reports).

As you let your FEd Executive Committee know what is important to you, please know that I will do my best to communicate our unit's needs and desires to the APS staff, so that they may better support you. We all recognize that this is a difficult time, and are working together to ensure we can keep doing our best work and stay sane.

From the Editor

Alessandro Cunsolo, *University of Wisconsin-Madison*

I am excited to introduce myself as the new editor of the Forum on Education Newsletter. I would also like to take this opportunity to thank Jennifer Doktor, my predecessor, for her dedicated service as Editor in Chief. My hope is that this newsletter inspires you to enhance your role in promoting physics education beyond our universities. If you have ideas for future newsletter themes or would like to contribute an article, please feel free to email me. This issue includes a message from the Chair, who emphasizes the vital role of education and introduces the members of the FEd community. I fully share her concerns about the challenging times our community is facing. The councilor provides updates on the APS GPS meeting, while the message from the past chair offers a helpful summary of awards within our community. Lowell McCann informs us about the Alpha Full Immersion initiative, summarizing its history and achievements. Sarah Parker highlights the TeachQuantum initiative at the University of Wisconsin-Madison, which aims to train high school teachers in quantum physics through hands-on laboratory experiences in the Department of Physics. Alma Robinson introduces two teacher preparation programs. The first is the Visiting Scientist Program, further discussed by Jolene Johnson, in which physics faculty deliver engaging lectures on various aspects of physics at high schools. The second is the QuarkNet initiative, described by Shane Wood, which consists of a network that engages teachers in authentic physics research activities, allowing them to bring these experiences into their classrooms.

ALPhA's Laboratory Immersions: "the most exciting, effective, and inspiring program"

Lowell McCann, *University of Wisconsin-River Falls*

Toward the end of the 2009 Topical Conference on Advanced Laboratories, a group of ALPhA (the Advanced Laboratory Physics Association) members gathered to talk about how else the group could help invigorate upper-level undergraduate physics labs. The conference, supported by NSF, AAPT, APS, APS FEd, and ALPhA, had been the first event ALPhA (founded in 2007) helped organize, so the group was looking at a wide variety of things that could be pursued.

A consensus emerged that while conference workshops were effective at getting faculty and instructional staff aware of instructional experiments, the limited time available made it impossible for them to get comfortable with all the (potentially subtle) aspects of the experiment. More in-depth hands-on experience was needed. The Laboratory Immersions were conceived that day to address that issue.

Immersions are typically 2-3 days in length, and participants use that entire time to focus on just one experiment. The goal is for participants to do the experiment just like their students would – running into common errors, working through difficult alignments, etc. – all with the support of a mentor who has taught the experiment themself. The primary goal is for participants to leave the Immersion confident that they could set up and teach the experiment themselves. A crucial, secondary goal is for the participants to meet each other and the mentors – creating a lasting network of lab instructors. In a typical year, 15-20 different experiments are offered at 10-12 sites around the U.S.

Moving quickly, ALPhA started the Immersions in 2010 – with volunteer mentors and support from TeachSpin. The organizers learned valuable lessons about what was effective and used that experience to obtain the first of a string of NSF grants, via AAPT, to partially support the Immersions starting in 2011. That funding lasted through 2023, when support from the Synopsys/ Reichert Endowment at the Jonathan F. Reichert Foundation was able to take the place of the NSF grants.

The support for the Immersions resulted because the Immersions have been successful, and participants (like the one quoted in the title above) have found them to be very useful. ALPhA surveys Immersion participants about 18 months after their attendance, so we have some numbers to indicate the success. For the Immersions in the years 2010 – 2023:

- There were 737 total participants (471 unique individuals, many who have attended multiple Immersions)
- A minimum of 36.6% of the participants (accounting for the 74.2% response rate of the surveys) had implemented at least a portion of the Immersion experiment by the time of the 18 month survey. We know that undercounts the actual 'success rate', because some of the experiments are costly, and it can take years for a faculty member to get the funds to incorporate a new experiment in their curriculum. Only 30 participants have reported that they did not intend to ever implement what they learned.
- Based on participant reports, over 2500 physics students in upper level undergraduate courses have been impacted by the program

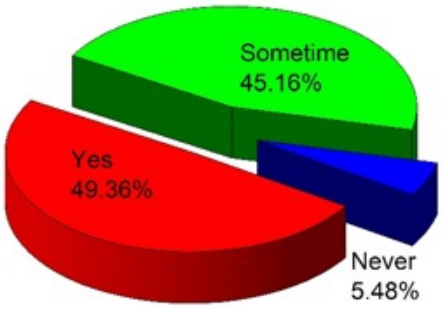

Figure 1: Survey responses to the question: "Have you implemented at least a part of the Immersion? If not, do you plan to do so in the future?

- 99.8% of survey respondents say that they would recommend that others attend an Immersion (and the *one* respondent who replied that they would not recommend Immersions also said that they planned to attend another Immersion...)

Since one of the main barriers to implementing a new experiment is the cost (though many of the Immersion experiments are very low cost), in 2016 the Jonathan F. Reichert Foundation began an Equipment Grant program for Immersion participants. Currently, participants can apply for support of 50% (up to $8000) of the cost of the equipment needed – with the home institution guaranteeing support for the remainder of the cost. The Foundation has awarded over $340,000 since the start of the program.

The 2025 Immersions begin in early June and run through mid-August at sites around the country. A complete listing of the offerings (for the current year and past years) can be found at advlab.org. Anyone interested in attending an Immersion or offering an Immersion at their own institution in the future can find contact information at that site.

TeachQuantum: A Hands-On Quantum Experience for High School Teachers

Sarah Parker, *University of Wisconsin–Madison*

Overview

TeachQuantum is a program which is held jointly at two locations: the University of Wisconsin–Madison and the University of Chicago. The program brings in five to six local high school teachers from various subjects to each university. The program involves a six week hands-on experience during the summer for teachers followed by quarterly check-ins. Each week, the teachers have an in-person component where they are introduced to a quantum concept through laboratory experiments, followed by a lunch where we invite a professional in the quantum field to give a 60 minute talk, and lastly an online component which serves as a guided session for curriculum development.

Laboratory Activities

In the first iteration of this program, teachers were paired with professors at each university to conduct actual quantum research in a laboratory. However, we found that the experience varied widely between each participant in different labs, the odds of conducting meaningful research in such a short time period were low, and the learning curve was extremely high. Instead of this Research Experience for Teachers (RET) model, we shifted to a model where teachers participate in a bootcamp in week one to introduce quantum concepts, then follow it up with hands-on experiments at the undergraduate or graduate level, depending on whether teachers are new or returning to the program.

In 2023, many of the teachers were new, so UW–Madison had teachers complete their hands-on component on Nitrogen Vacancy (NV) Centers. NV Centers are essentially a defect in the lattice structure of a diamond, which allows you to measure certain properties, such as the spin state of electrons in the material. NV centers are generally used as the basis for quantum sensors and as the basis for certain types of quantum bits, or qubits, in quantum computing.

By 2024, we had five returning teachers in the program and we wanted to provide them with different material in quantum physics. Teachers were able to explore experiments such as: Stern-Gerlach Experiment, Zeeman Effect, Optical Pumping of Rubidium, Pulsed Nuclear Magnetic Resonance (NMR), and Bell's Inequality. Each of these labs covers a foundational discovery in the history of quantum physics, and more specifically quantum sensing.

We received positive feedback from the teachers about the new model of this program. Not only were they introduced to these new topics, but multiple teachers stated that it allowed them to step into the shoes of their students. They were able to explore a new topic, perhaps one that frustrated them initially, and work through it from the lens of their student experiencing a new topic for the first time. They stated that this was something incredibly valuable to them as they were creating their classroom lessons. This allowed them to view the approach to their lesson in a new light and focus on what will help their own students with overcoming difficulty and coming to an understanding of the concepts they are learning. They noted that often their students have a better understanding of topics after participating in a hands-on experience, much like the teachers did.

To supplement these labs, we also provided discussions from the lab instructor, Alessandro Cunsolo, who was able to answer any lingering questions for the teachers. We also provided Lunch & Learns from quantum professionals on campus who provided talks on various use cases of the topics the teachers were learning.

Curriculum Development

Each week the teachers would have virtual synchronous sessions where they were able to brainstorm, connect their laboratory work to curriculum, and work on developing a lesson to fit into their own classroom. Every session, they would gradually build upon the prior week's work; exploring Next Generation Science Standards or Common Core Standards (depending on which topic they taught), using Jamboards to think of ideas to implement, building lessons, sharing and receiving feedback with the other teachers, and finally ending with a fully fleshed out lesson to give to their students. While our expectation of teachers is to just introduce any quantum topic in their classroom, teachers often choose to share with students something that they find particularly fascinating in the laboratory.

We have had teachers from different disciplines such as physics, chemistry, biology, math, and computer science participate in the program; and as such they have created some incredible and unique lessons in return. Chemistry teacher Jamie Lauer created a lesson connecting the Zeeman Effect to migratory patterns in birds, while math teacher Matt Lane used the concept of pulsed NMR to help teach exponential functions by exploring various liquid solutions and the speed at which they return to equilibrium when disturbed. We have had many amazing lessons come out of the TeachQuantum program, that use various educational techniques such as gamification and storylining, which are often met with positive reviews from their students. The TeachQuantum program is looking forward to publishing these lessons for broader use by teachers across the country, or perhaps even the world.

Sarah Parker is the Quantum Outreach Program Manager at the University of Wisconsin–Madison. She is the facilitator of TeachQuantum in Madison and the Wonders of Quantum Physics Program.

PhysTEC Section on Teacher Preparation

Alma Robinson, *Virginia Tech*

There are many ways that university physics departments and practicing physicists can engage with and support high school physics teachers. This edition of the Teacher Preparation Section features two programs that have connected high school physics teachers and their students with the larger physics community.

Jolene Johnson describes how she and her colleague at the University of Wisconsin–River Falls, Lowell McCann, created the Visiting Scientist Program. Through this initiative, university faculty visit local high schools to teach a physics class for a day or a period, providing students with the opportunity to engage with practicing physicists. This program also fosters stronger relationships between high school teachers and university faculty, benefiting both parties.

One of the most prominent programs designed to connect practicing physicists with high school physics teachers is QuarkNet. Shane Wood highlights the program's 25+ year history of creating authentic high-energy physics research experiences for high school physics teachers and their students. QuarkNet offers a variety of programming across the United States through local centers at universities and national labs, while also providing opportunities for teachers and students who do not live near a center to participate in monthly virtual meetings.

PhysTEC's annual workshop, the largest annual gathering of physics teacher educators, will be held on August 2-3 in Washington, DC, as part of the AAPT summer meeting. For more information, please visit: https://phystec.org/events/2025-workshop//

Supporting Physics Teachers

Jolene Johnson, *University of Wisconsin–River Falls*

If you ask most physics majors how they became interested in the subject, many will trace their interest back to a high school physics class. In fact, a recent report found that 72% of physics majors first became interested in physics during high school (Ivy AIP, 2024). My own experience reflects this trend. I had wanted to become a scientist since fifth grade, but it wasn't until my high school physics class—where we read A Brief History of Time by Stephen Hawking and conducted engaging experiments—that I seriously considered majoring in physics.

That experience set me on a path to earn a physics degree, complete a Ph.D., and become a faculty member. In an unexpected turn, after my university's physics department was closed, I spent four years teaching high school physics in inner-city schools—including during the COVID-19 pandemic. That experience profoundly shaped my perspective. It made me keenly aware of the immense challenges high school physics teachers face and the lack of professional respect they too often endure.

Since returning to higher education, I have prioritized supporting physics teachers in meaningful ways. I would like to share a few of those efforts here, in hopes that others in the physics community might be inspired to consider how they, too, can support the educators who are so often responsible for launching physics careers.

At the University of Wisconsin–River Falls, my colleague Lowell McCann and I launched the **Visiting Scientist Program**. Each fall, our physics faculty compiles a list of short, engaging class sessions we are willing to teach at local high schools. Some sessions involve equipment that many schools lack (e.g., materials testing tools), others focus on areas of faculty expertise (e.g., biophysics or astrophysics), and some are rooted in topics we are passionate about (e.g., diversity in physics). We distribute these offerings to area physics teachers along with a short survey to help us schedule visits.

We work closely with each teacher to arrange for one or more faculty members to take over their classes for a period or a full day. Our goal is to support teachers and offer students the opportunity to interact with practicing physicists while exploring exciting topics. Personally, I've had the pleasure of teaching rural Wisconsin students about the polarization of light and working with students in St. Paul on light-up holiday cards among many visits. As a former high school teacher, I know firsthand how valuable it is to have even one day without the burden of lesson planning and materials preparation. We strive to ensure that this program reduces teachers' workload, rather than adding to it.

This program has also provided invaluable insight into the current landscape of physics education in our region. Through classroom visits and informal conversations with teachers—often over lunch—we have learned which schools are at risk of

losing their physics programs, what challenges teachers face, and what supports are lacking. This feedback directly informs our own teaching practices, including how we prepare science education majors and the kinds of professional development or graduate-level summer courses we consider offering.

One particularly meaningful outcome of these connections was an invitation to provide professional development for all the physics teachers in a local school district. As a former high school teacher, I deeply understand how frustrating it can be when no one outside the classroom seems to listen to you. Teachers are experts in their own classrooms, yet their voices are often overlooked when decisions are made about curriculum, resources, or educational reform.

When leading professional development, I made it a priority to listen. I created space for teachers to share their concerns and needs. In some cases, I could offer immediate support—such as providing ideas for low-cost fluids labs for the new AP Physics curriculum, or sharing resources like STEP UP that support recruiting and retaining students from underrepresented groups. In other cases, I simply listened and took their feedback back to colleagues and decision-makers. For example, I learned that the district had declined to purchase materials aligned with new state standards—a particularly serious concern given how many science teachers are now being asked to teach physics without adequate training or resources.

As a professor, I can amplify teachers' concerns in ways they may not be able to. I can write to local school boards, raise awareness through op-eds, or bring their concerns to national groups. And sometimes, just being heard and respected makes a real difference. Several teachers told me it was the best professional development they had ever received—because the presenter listened.

We all bring different skills and resources to the table as physicists. To support the future of our discipline, we must use those skills to uplift and support our teachers. You might consider offering a workshop on a new state standard or AP topic. You could create a visiting scientist program through your university, lab, or company. If you have equipment your local high school could use, consider donating it or helping the teacher write a grant. If you're engaged in physics education research, invite a teacher to collaborate—while compensating them for their time and expertise.

And above all, speak up on behalf of teachers. Attend a school board meeting. Write an op-ed. Share their stories with your colleagues. Teaching high school physics was the hardest job I have ever had. Those who do it well deserve our respect—and our support.

Jolene Johnson is a physics professor at the University of Wisconsin–River Falls, where she conducts research in biophysics and physics education. Her husband is a mathematics teacher, and she is passionate about improving physics and math instruction for students at all educational levels.

QuarkNet: Supporting Physics Teacher Communities for 25+ Years

Shane Wood, *QuarkNet*

For over 25 years, the QuarkNet Collaboration has provided sustained professional development and collaborative learning for high school physics teachers across the United States. With its unique blend of research opportunities, professional growth, and an active community of educators and scientists, QuarkNet has played a significant role in enhancing physics instruction at the secondary level. By fostering a deep connection between teachers, students, physicists, and cutting-edge particle physics research, QuarkNet has empowered educators to bring authentic scientific experiences into their classrooms.

Origins and Mission

QuarkNet was founded in 1999 with support from the National Science Foundation (NSF) and the U.S. Department of Energy (DOE). It was developed to respond to the need for stronger connections between high school physics teachers and the evolving landscape of high-energy physics (HEP). The program's mission has remained steadfast: to foster a network that immerses teachers in authentic physics research while equipping them with instructional strategies and best practices to bring these experiences into their classrooms.

The foundation of QuarkNet lies in its deep connection to the HEP community. By partnering with university-based research groups and national laboratories, the program immerses teachers in real-world investigations, from analyzing data from the Large Hadron Collider (LHC) and Fermilab-based experiments to exploring cosmic ray detection. These experiences translate into enriched classroom instruction that connects contemporary physics to academic standards, where students can engage with authentic data and develop an understanding of and an appreciation for the nature of scientific discovery.

Structure and Components of QuarkNet

QuarkNet operates through a network of centers at universities and national labs across the U.S. Currently, over 50 QuarkNet centers (see Fig. 1) provide local support to teachers within its region. In addition, one virtual center brings together QuarkNet teachers who are not located geographically near a QuarkNet center with monthly virtual meetings and occasional opportunities to meet in person. The program supports several key components, including (but not limited to):

1. **Center Activities & Workshops** – At each QuarkNet center, mentor physicists and lead teachers collaborate with QuarkNet staff to recruit local teachers and provide workshops. As a long-term professional development program, QuarkNet fosters lasting relationships between teachers and physicists, creating a close-knit community. Teachers come from diverse backgrounds and schools, enriching discussion and learning. Workshops blend local content--such as scientist talks, lab tours, and teacher-led sessions--with national QuarkNet workshops on topics such as cosmic rays, LHC and neutrino data, quantum physics, and relativity. Each session includes a combination of data-driven activities and time for teachers to reflect on classroom applications. Many centers also host particle physics masterclasses (described below) and institution-based events. QuarkNet provides stipends and professional development certificates to participants.

2. **National Camps** – QuarkNet camps bring teachers together in person or virtually for professional development and community-building. Data Camp, held at Fermilab, immerses teachers in particle physics data analyses, facility tours, and classroom activities. Coding Camp 1 (virtual) introduces Python programming and classroom applications, while Coding Camp 2 (in-person, supported by IRIS-HEP) deepens coding skills for data analysis. Lead

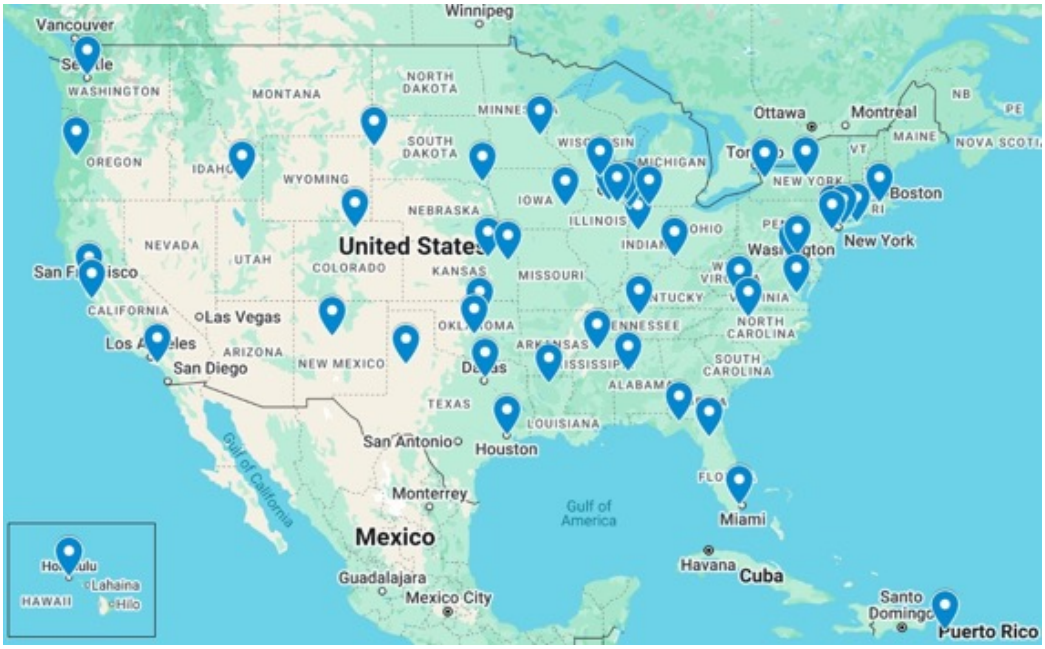

Fig. 1 Location of QuarkNet centers as of April 2025.

Teacher and Fellows Camps strengthen teacher leadership, helping QuarkNet staff support over 500 educators nationwide. Each of these experiences includes time for participants to build and share plans on how they will implement ideas and activities they have learned about. Participants receive stipends and travel funding for camp attendance.

3. **Masterclasses** – Each year, over 13,000 students from around the world participate in a particle physics masterclass at a local university or lab during the approximately month-long masterclass season. Many QuarkNet centers host a masterclass each year for nearby high school students. During a masterclass, students become "physicists for a day," where they learn about particle physics, analyze data, discuss results, tour facilities, and participate in a videoconference moderated by a physicist at CERN or Fermilab. In addition, QuarkNet, along with the International Particle Physics Outreach Group and other partners, works to support and organize resources and videoconferences for these masterclasses.

4. **Data Activities Portfolio (DAP)** – The QuarkNet DAP is a collection of over 40 data-driven activities that help teachers and students learn physics concepts and skills, including analyzing authentic data from experiments at CERN and Fermilab. Tailored for high school classrooms, these activities are organized by data strand, student engagement level, curriculum topics, and Next Generation Science Standards (NGSS). Teachers typically explore these activities during workshops and camps, first experiencing them in "student mode" before transitioning to "teacher mode" to discuss classroom applications. Each activity is aligned with NGSS, AP, and/or IB standards, enabling educators to connect fundamental physics concepts with cutting-edge research and modern experiments.

5. **Cosmic Ray Studies** – QuarkNet Cosmic Ray Studies are supported by Fermilab and include a network of cosmic ray muon detectors (CRMDs) on loan primarily to QuarkNet teachers to use at their schools with their students. Each CRMD consists of scintillator counters, photomultiplier tubes (PMTs), a data acquisition card (DAQs), and other components that allow data to be collected and stored locally. Then, the data can be uploaded to the Cosmic Ray e-Lab, an online platform that allows anyone with an e-Lab account to analyze data from any detector that has uploaded data. This enables users (including teachers and students) to collaborate and to investigate cosmic ray flux, muon speed, muon lifetime, and other investigations that the user may propose.

Conclusion

QuarkNet has spent over 25 years building a thriving community that connects high school physics teachers with the forefront of particle physics research. Through its network of centers, professional development workshops, national camps, and student-focused programs, QuarkNet continues to empower educators with the knowledge, resources, and experiences needed to bring contemporary physics into their classrooms. By fostering collaboration between teachers, students, and scientists, QuarkNet ensures that the next generation of learners engages with authentic scientific discovery, sparking curiosity and deepening students' understanding of physics.

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Shane Wood is a physics educator residing in Minneapolis, Minnesota. He serves as a National Staff Member for the QuarkNet program. He also works part-time supporting science teachers in the Mounds View (MN) School District.

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